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SOME AMERICAN OPINIONS ON THE EDISON LAMP CASE.

ALTHOUGH the judgment in the great case of the Edison Electric Light Company *versus* The United States Electric Lighting Company has not yet been pronounced, and notwithstanding that there is nothing fresh to be elicited that can influence the judge in his summing up of the facts, the interest shown in the matter is unflagging, and, as a result, there is a publication of endless articles and letters replete with conjectures as to the final verdict, and as to the evidence on which the Court can found its opinion.

All sides in the United States appear to agree that to Mr. Edison is due the credit in establishing and making feasible the modern system of incandescent electric lighting; that the intent of the Patent Laws is to confer substantial rights on the person who introduces some invention which shall be of service to the public; and if that were the only point to be decided in the present case there would be no doubt of the issue.

The statutes require, however, that an inventor should comply with certain conditions well understood, and that his description of his discovery shall be conveyed in language such as shall leave no difficulty or reservation in the way of preventing the public fully understanding the terms of the patent, and shall enable, on the expiry of the patent, anyone to manufacture or practice the invention. The claims should be described so clearly that other persons shall not innocently infringe them.

In 1879 Edison conclusively demonstrated to the world that an invention had been made, which solved the problem of subdivision of the electric light by incandescence lamps. What was the nature of this invention?

The experts who have borne witness for Mr. Edison in the present trial substantially agree in their definition of this invention, viz., a filament of carbon, of high resistance and small radiating surface, sealed into an exhausted all-glass globe. The wording of the claims probably leave them no alternative but to take up this position, and the question now arises whether the claims of the patent are not based on a total misconception of the real character of the invention which it was desired to protect. This misconception may be fatal to the patent.

Several things tend to lead to this conclusion. One was the production, by the defendant, of a certified copy from the files of the Patent Office, from which it appeared that Edison had endeavoured to obtain a subsequent patent defining the invention more accurately, and claiming it more broadly.

Another point was the unavailing effort of the counsel for the defence to obtain, either from the witnesses or the counsel for the complainants, any definite or precise meaning of the terms *filament* or *high resistance*, the essential part of the claims in the Edison patent. The question was answered in a dexterous and evasive manner, which utterly failed in the slightest degree to elucidate the subject. It was asked whether a burner of 4 ohms resistance could be called a *high resistance* or not, but no lucid information could be dragged out of the witnesses.

It is clearly evident on the face of it that a burner of the lowest resistance might embody Edison's real invention as much as one of 1,000 ohms. And the deduction may be drawn that no satisfactory answer was forthcoming to the question, because the claim was not co-extensive with the actual invention, but only covered some of its incidental and unimportant features. If then the Edison claims do not plainly state what any person may not make without being called an infringer, the patent must be null and void, for it will be drawn in direct opposition to the provisions of the statute.

The real invention which raised the incandescent lamp from a scientific toy to a practical and commercial article, was the use of a burner made of carbonisable matter, which is first formed and then carbonised. The modern incandescent lamp is a two-fold invention—a process and a product. Edison's merit consists in the adoption of a process essentially new, which enabled him to make his carbons to any desired form or resistance. Sawyer and Man may have invented or conceived the idea, but Edison, by superior energy and diligence, produced the modern lamp.

The Courts have always held that the claims of a patent should be liberally construed in favour of a deserving inventor, but that claims should state precisely what the invention is. It has been observed by one of the judges: "If a claim is ambiguous and uncertain that its true meaning cannot be made out without resorting to conjecture, or if it includes what is old, then the patent is void." "It is just here," says a correspondent to the *Electrical Engineer* of New York, "that the difficulty is likely to arise in the case of the Edison patent. What, for example, are the qualities necessary to constitute a 'filament'? Is it a matter of dimensions, or of proportions or of form, or of structure? Neither the patent, the counsel, nor the scientific witnesses have found themselves able to formulate a definition. What is *high resistance?* Is it high specific resistance, or high total resistance? And by what standard is the height of resistance to be measured? These and many other questions which might be asked are by no means easy to answer; but no such difficulty could have arisen had the claims of the patent been so worded in the first place so as to embrace the real invention which it was sought to protect."

PORTABLE MINERS' LAMPS.

IT would be interesting to learn to what extent portable miners' electric lamps are employed in the coal mines of this country, in what portions of the collieries they are in use, and the general results of their adoption. This subject, although of secondary importance in so far as electricity in mining operations is concerned, is still of considerable interest both to those firms who have taken up the manufacture and sale of the numerous miners' electric lamps now on the market, and to the coal mining community at large. We say of secondary importance advisedly, because experience in mine lighting has up to the present shown that in the "main roads," and we believe this is also partly the case in the principal galleries, permanent installations have been adopted with good results; this practice may therefore be regarded as a criterion for future development. As far as we are aware, very little has been done in the use of portable electric lamps beyond experiments which have been or are still being conducted in a few mines; but possibly some of our readers may be able to throw light on this point.

In the REVIEW of the 20th September, 1889, we discussed the subject of miners' lamps, and the conclusion there arrived at was that a portable lamp would eventually be produced that would be as cheap, nearly as light, and more efficient than the ordinary safety lamps in use, but the question as to whether a primary or a secondary battery lamp would be the best we did not venture to predict. Since that time lamps have been placed on the market at about one-half the prices then prevailing, the weight has been reduced, and the lighting efficiency increased. Yet these important advances, which have mainly taken place in the case of primary battery lamps, do not put electric miners' lamps in a position to compete in any way with those ordinarily used. This is, however, not all. It is generally supposed that lightness, cheapness and efficiency are the only essentials which should characterise a good lamp, but this is not the case. Attention must also be paid to the position in which the bulb of the incandescent lamp and its protecting bull's eye or other glass covering are attached to the battery casing. This may appear strange, but the miners themselves, and we believe some mining engineers also, are rather fastidious on this point. In order to show to what extent this is so, it may be mentioned that at a recent meeting of the the miners' delegates of the United Kingdom at the Westminster Palace Hotel several miners' electric lamps were brought under their notice. Apart from the questions of price and weight the delegates generally were pleased with the lamps, but they were not satisfied with the position of the bulbs. Some of the delegates were in favour of a miner's lamp with the bulb arranged as is the light in an ordinary lamp, or in front at the top of the battery case, or at the lower front of the latter. Others desired a battery with two lamps, the first arranged on one side and the second on the opposite side, whilst a lamp with the bulb on the top of the case was considered by another delegate to be a *desideratum*. Some of these different arrangements are fulfilled by certain lamps, but not all. It would, however, not be very difficult to meet all the above requirements should occasion arise, but it is doubtful whether the opportunity will present itself.

We are not particularly in love with primary batteries, so many different kinds of which have turned out to be "wonderful inventions," from which light was, by reason of the "valuable by-products," said to be obtained for a mere trifle. Considering, however, that in the improved miners' lamps brought out during the past two years the primaries have taken the lead, there seems reason to suppose that the primary battery miners' lamp will for the present command more attention than the accumulator lamp. Whilst the charging of lamps of the latter type would occupy considerable time, and could only be effected properly in large numbers by a dynamo, those of the former kind could be recharged with despatch by an inexperienced man. Of course a secondary battery lamp may be introduced which will be superior to any primary. At all events, the ideal lamp appears to be one which will combine not only cheapness, lightness and efficiency, but also the possibility of so arranging the battery and lamp (during construction), that the bulb of the lamp may be placed according to requirements.

INSULATION TESTS.

ON many previous occasions we have drawn attention to the advantages which accrue from the systematic testing of all insulated wires and cables; but the legal action, which was reported in our last issue, shows that the practice is not so common as we think it should be, either with the manufacturer of the wire or with the contractor who uses it. Surely the importance of such tests must be evident to all, as it has been for many years to the telegraph engineer, who tests not only his cables but also his wire and insulators for land lines, and indeed nearly all his electrical stores, and makes sure by these means that they come up to the specification on which they have been ordered.

A similar practice will, we think, have to be adopted sooner or later when ordering electric light material; and although the contractor might urge the impossibility of testing every length of wire which he uses, he should have no difficulty in exacting from the manufacturer a guarantee or a statement of the result of the test on each piece of cable,

and in making a check test every now and again. We certainly should be surprised if we found that boilers, engines, or dynamos were supplied without being tested, but we are afraid that it is much too common a practice with the electrical engineer, who would draw up an elaborate specification for his generating plant, to leave his cables to look after themselves, and to buy them without specifying anything about them himself, or even getting from the manufacturer a specification of what sort of test the particular class of wire will stand.

So long as this practice prevails we are afraid that every now and again there will come a dispute such as the present one, which might have been avoided altogether, if only reasonable precautions had been taken on both sides to come to an understanding as to what was required of the wire, and how far it was likely to fulfil those requirements; and we are therefore glad to find that many of the supply companies, who are spending large sums of money on underground mains, are beginning to recognise the importance of knowing what they are putting down, and are not only insisting on an insulation test but, when high pressures are to be used, on a test for capability of withstanding disruptive discharge. These two tests, although not telling us all we want to know about the cables, may be made to give very valuable information; the insulation test will show whether the material used is of regular quality and has been properly applied, and the breaking-down test, if a pressure, say, 50 or 100 per cent. greater than that at which they are to be worked is applied, will break down any incipient faults which might develop after use, although not bad enough to show up with a test made in the ordinary way with four or five hundred volts. The regularity of the insulation resistance is a point which can hardly be made too much of, as the cable which ought to give 500 megohms per mile, and does so, is in many cases preferable to one that should give 5,000 megohms, but actually only tests up to 2,500, as it is evident that the falling off of the resistance below the standard must be due to some fault in manufacture, which may very likely develop after the cable has been in use for a time, and eventually become so serious as to prevent the cable from being worked.

The Application of the Principle of Pressures to Widely-separated Telephone Transmitters.

MONS. P. GERMAIN recently contributed a note on the above subject to the Academy of Science at Paris. In effect, he said that the embouchure of a telephonic transmitter without the battery may be subdivided into a certain number of smaller embouchures, each corresponding above to the splay of the air chamber of a distinct telephonic armature. The emission of a single voice determines in all the columns of air and on the telephonic armatures, pressures which are proportional to the total surface of the armatures influenced. Each armature develops in the electro-magnet induction currents which are similar, or else equal, in all the equal and distinct circuits composing the transmitter. By connecting up the beginning of the current in the first coil with the end in the second, the beginning of the second with the end of the third, and so on, to the last, and by intercalating all these circuits grouped in series into the circuit of a telephonic line, it is possible to telephone great distances without the aid of the microphone, without the battery of constant quantity, and without the Edison coil. A battery in series for the calls is sufficient and is able to serve a certain number of telephonic posts. In order to serve a telephonic line of 4,000 ohms resistance, the embouchure of emission being only 12 square centimetres, the total surface of the armatures separately influenced by a small embouchure of subdivision ought to be 900 sq. cms. The total resistance of the "Bell" coils ought to be 2,000 ohms.

The Cost of Electric Lighting.

IN our review on Mrs. J. E. H. Gordon's book, "Decorative Electricity," we alluded to the error into which that lady had fallen with respect to the relative cost of electricity and gas. We observe that a reviewer in last week's *Engineer* has the same hazy notion on this important point, for he says: "It is rightly pointed out that although electricity is about 20 per cent. more expensive than gas, &c." Now we would like to ask that reviewer where it is possible to get an electrical supply at so small a cost above that of gas; we do not know, but if he would kindly give us the information it would immediately push electric lighting along in leaps and bounds. For our own part we think that the relative costs still remain in much the same position as shown in the figures more than once quoted by us, viz.: that, light for light, electricity at 7d. per unit is equivalent to gas at 7s. per 1,000; 8d. per unit, to 8s. per 1,000, and so on.

Gas *versus* Electric Light.

A LIVELY bungle occurred in connection with the proceedings at the recent meeting of the Incorporated Gas Institute at Carlisle. Mr. A Edwards, of the Taunton Gasworks, was announced to read a paper on "Notes on Competition with Electric Light." After being twice revised, the author of the paper was asked on the last day of the meeting to make a third revision. This he declined to do, partly on the ground that the statements in the paper were correct, and partly because he was not accustomed to being humbugged. Mr. Edwards has now notified his intention of withdrawing from the Institute, and he states that the history of electric lighting in Taunton will be published, although it was deferred for a time by the action of the Council. On the other hand, the latter explains that the paper "contained remarks which, if published, might have led the Institute into legal difficulties." As the Taunton Electric Light Company has been established for some years, Mr. Edwards should have had excellent opportunities of instituting a comparison between gas and electric light; but we believe that the paper dealt to a great extent with the general *modus operandi* of the company. At all events, it is a pity that the reading of the paper was deferred. Possibly Mr. Edwards will bring his paper before the Institution of Gas Engineers or one of the other technical societies.

Undergound Telephone Cables.

REFERRING to our comments in our issue for May 29th, on paper insulation for telephone cables, the New York *Electrical Review* says:—"The great gain has been made by abolishing the filling of paraffine or compound and thus obtaining a dielectric of cotton or paper and air only. The insulation resistance of the cable is by no means impaired, if anything it is improved, and in any case it is always far above the requirements. If anything happens to the lead pipe repairs must be made, because the insulation will fail whether the dielectric is paper and compound or paper and air; therefore as far as insulation is concerned, the cable is just as well off without the compound as with it. But, of course, a great reduction is effected in the capacity, as the spaces which were previously occupied by compound are now filled with air, which has the lowest specific inductive capacity of any dielectric known. Given a little American ingenuity in arranging the paper covering on the conductors so as to obtain the maximum amount of air space with the minimum of paper necessary to keep the conductors properly separated, and our contemporary will readily see that the combination permits of securing a cable having a very low inductive capacity."

THE PROTECTION OF BUILDINGS FROM LIGHTNING.*

By C. J. HUBBELL.

I NOTICE, among the Transactions of the American Institute of Electrical Engineers at a special meeting held April 21st, 1891, a paper was read by Mr. N. D. C. Hodges, "On Possible Modifications in the Methods of Protecting Buildings from Lightning," which provoked considerable discussion among the members present, and during which my name, as "a well-known lightning rod manufacturer," was mentioned by Mr. Edward P. Thompson in connection with a series of experiments.

I would like to say a few words in answer to Mr. Hodges's theory, that a dissipated conductor protects. He asserts, moreover, that there is no instance on record where a dissipated conductor has failed to protect. It is a well-known physical law, that can be readily proved to the satisfaction of any intelligent person, that the earth is a permanent magnet, and the rendezvous of all thunderstorms. When a cloud, charged with a given kind of electricity, approaches the earth, the latter, that is the subterranean sheet, or permanent moisture belt, becomes charged with an electricity of an opposite polarity. The two electricities attract each other; the electricity of the earth precipitates itself upon the lines of least resistance, gathering up in increasing intensity to the higher points under the attraction of the storm cloud, until sufficient potential has accumulated to overcome the resistance of the dielectric, when a discharge takes place and the equilibrium is restored.

There are more, what is commonly called, "upward strokes" than "downward" ones, and more disasters have occurred from the former than from the latter. Yet Mr. Hodges ignores the earth connection entirely, without even resorting to the method of Clerk Maxwell by insulating the building from the earth. I might say to Mr. Hodges, with more truth than is contained in his assertion, namely, "that there is no instance where a dissipated conductor failed to protect," that there is no instance on record where a well-ordered and properly constructed lightning conductor of sufficient capacity and good and intimate connection with the subterranean water bed or permanent moisture belt, failed to protect.

I herewith submit a few well authenticated instances where a dissipated conductor failed to protect. Anderson, in his well-known and standard work on "Lightning Conductors," contains the following passages bearing directly on this subject:—

Page 315. Date, July 21st, 1745. Tower of Monastery of Bologna. Result: Shattered. Lightning followed conductor and *melted it.*† Authority, Reivnarus Bl. 93.

Page 315. May 31st, 1748. Top of a church tower, Witzendorf, shattered and tore off the roof. *Melted the conductor.* Authority, *Hamburg Magazine*, IX., 301.

June 16th, 1754. Belfry of Newbury Church damaged, point of spire shattered and other damage. *Conductor melted.*

Page 186. Prof. Landriani, of Milan, draws attention to the paramount importance of a perfect earth connection.

Page 312, same authority. On Trinity Sunday, June 8th, 1879, a violent thunderstorm broke over the town of Arxham about half-past three in the afternoon, and the spire of St. Mark's Church was struck by lightning. A Sunday school class was being held in the room at the base of the spire, and the teacher and five of the scholars were burnt. Some of the stone work of the spire was also displaced and thrown down. Cause: A copper conductor of too small capacity and the earth connection not adequate.

Many more instances could be given in addition to the above.

Referring to the article in the London ELECTRICAL REVIEW, quoted by Mr. Hodges, in which it is said that lightning does not play as destructive a part as it did 40 or 50 years ago, and that even those ships unprovided with conductors had suffered less damage than a smaller number of ships experienced formerly, &c., I reply that the reason that modern vessels are less frequently injured by lightning than formerly, is because of the fact that more vessels are now built of iron, and the still more important reason that wire rigging instead of rope, as formerly, is almost universally used, while, in addition, the masts of many vessels are of iron, and hollow. I could cover many pages with what should be accepted as strong evidence for the necessity of a good earth connection, and a refutation of what I cannot but regard as a very unscientific statement, based upon no valid reasoning, that a dissipated conductor protects. Certainly Mr. Hodges, with his strip of copper 75 feet to the pound, placed as an offering to the insatiate monster in order to protect the structure, magazine, &c., it is tacked on to, has but a very small conception of the potentiality of a discharge of lightning whose disruptive powers are such as to hurl tons of granite from their foundation as if they were but feathers, so that it may take the path of least resistance, to the water which it was seeking in order to be *dissipated* by being neutralised.

In conclusion, I desire to correct a statement about myself made by Mr. Thompson. It was five years ago, not three, that Mr. Thompson, upon my invitation, came to a room in the Standard Oil Company's new building to witness my experiments with a six plate electrical machine, using a spheroid as a cloud. The gas from the gas pipe in the room was used to charge the model oil tank used in the experiments. Profs. Morton, Plympton, and Nason, of Troy, were also present, and the experiments were absolutely successful; but because I refused to dispose of my invention for a trifle, the company refused to adopt it.

I applied the same principle to the U.S. Government magazine, at Dover, N.J.; also to the Wellesly College building at Wellesly, Mass., where nine conductors, all of which were tested by Prof. Holman, of the Mass. Inst. of Technology, Boston, showed the highest resistance of ground or conductor to be ·3 of an ohm. I also predicted the striking of the Washington Monument, giving my reasons for the same, and my prediction was fulfilled when, three weeks later, the capstone was shattered. I was called upon to advise a method of protection, and in response to suggestions, the connection of all masses of metals about the plinth was carried out, and a crown with many points substituted for the single aluminium point; since then no further disturbance has occurred.

* *Electrical Engineer*, New York.

† These, and the subsequent italics, are mine.

THE DIELECTRIC PROPERTIES OF MICA AT A HIGH TEMPERATURE.

AMONGST the papers read at the Paris Academy of Science on June 8th was one by Mons. E. Bouty, who gave some account of his recent examination into the dielectric properties of mica at elevated temperatures.

Mons. Bouty has investigated these properties at temperatures ranging from the ordinary temperature to about 400° Centigrade, and his results are evidence of the fact that the dielectric constant of mica is almost completely invariable.

Laminæ of silvered mica were employed, and no special difficulty was experienced with them until the temperature was raised to about 300° Centigrade. At this temperature the thin layer of silver was attacked by the air, and the mica became covered with a transparent film, which seemed to be connected with some electrolytic process. The inconvenience attached to this circumstance was however fortunately eliminated by covering the layer of silver with a protective layer of deposited copper.

From 0° to 300° Centigrade, it appears from these researches, that the dielectric constant of mica certainly does not vary more than $\frac{1}{50}$th of its value; and since throughout this interval of temperature the "electric residue" is not particularly great, this can be decidedly demonstrated.

Beyond 300° Centigrade complications appear. The electricity supplied to the condenser by the battery ceases to be employed exclusively in the formation of a recuperable residue, as was observed at the ordinary temperature. (*Vide Comptes Rendus*, t. cx., p. 1,362.) The excess of the charging current over the residue is connected with the existence of a superficial conductivity of the mica, which itself is probably a result of the plates being attacked, for at a fixed temperature this conductivity increases rapidly with the increase of time, that is to say, with the visible alteration produced in the silvering.

If after prolonged heating the condenser be allowed to

cool, the superficial layer of the mica becomes hygroscopic, retains in the cold a conductivity which can be made to disappear by washing the edges with alcohol, and then the mica returns to its normal properties: its internal properties will not have been at all affected by the heating. It is possible that between the temperatures of 300° and 400° Centigrade mica possesses a feeble conductivity of its own, and that this is added to the superficial conductivity observed by Mons. Bouty; but so far as experiments go, this has not yet been satisfactorily demonstrated.

Whatever may really be the case, the resultant conductivity between 300° and 400° Centigrade is so small that it may be neglected in experiments of short duration. By means of a torsion pendulum such as Mons. Bouty has used in previous experiments [*vide Comptes Rendus*, t. cx., p. 1,362], he has produced a closing of the circuit varying from 0·001 s. to 0·05 s., and has found that during this restricted interval the charge, C, absorbed is represented in function of the time, t, by the formula:

$$C = A + B t^{\alpha}.$$

The coefficient B, characteristic of the residue, increases rapidly with the temperature, but A possesses a more steady value, and differs but little from the value when experiments are made at lower temperatures.

Mons. Bouty is led to conclude from his investigation that the dielectric constant of mica is very stable, and that its variations with temperature appear to be of the same order as those of the density or the index of refraction.

THE PARIS COMPRESSED AIR COMPANY AND GERMAN CAPITALISTS.

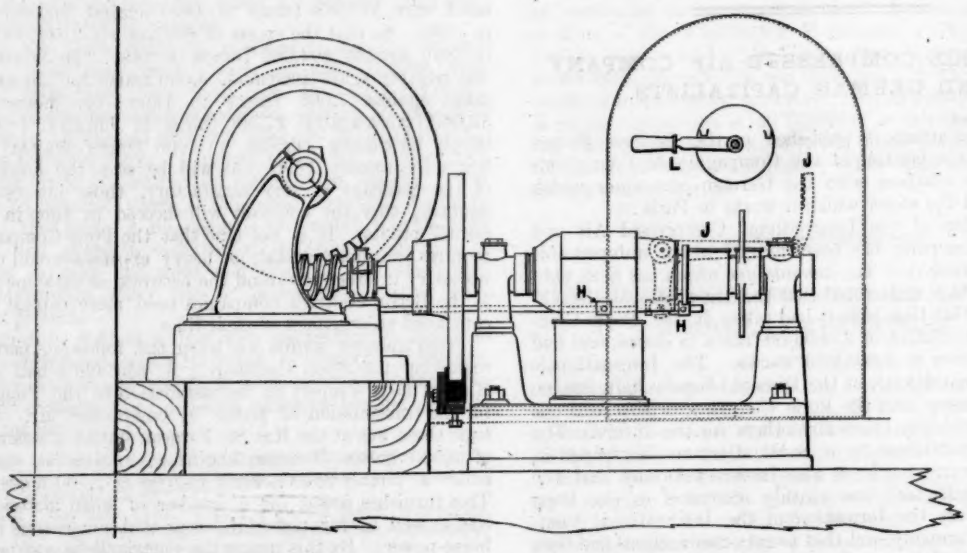
The following article is published in the *Berliner Börsen Courier* as to the position of the Compagnie de l'Air Comprimé and its relations with the German companies which have acquired the sector which it works in Paris:—

The position of the International Compressed Air and Electricity Company has been judged in an unfavourable manner, on account of the *communiqué* which has been published. We have announced that the Internationalé Druckluft Elektricitäts Gesellschaft had taken in the Popp Company the participation of 6,800,000 francs in shares, and had made an advance of 5,898,000 marks. The Internationalé Druckluft Elektricitäts, or the Disconto Gesellschaft, has no other engagement with the Popp Company, neither the one nor the other having taken any others for the future. The information published by a South German newspaper is, therefore, incorrect. It is also incorrect to say that the Disconto Gesellschaft was already interested in the Popp Company before the formation of the International Compressed Air Company, and that twenty-two millions had been invested by the Disconto Gesellschaft in the Popp Company. The interests of this group in the Popp Company are only those of the Internationalé Druckluft Elektricitäts Gesellschaft. This should, before everything, put an end to the exaggerated rumours which have been circulated relative to the interest of the Disconto Gesellschaft in the Popp Company. As far as concerns the development of the latter company, it should in the first place be remembered that the sector which has been conceded to this company by the City of Paris is the best in the city, and includes, among others, the grand Parisian boulevards. [This is wrong, since all the Paris electric light companies have access to, and a canalisation on the grand boulevards.] According to the stipulations of its concession, the Popp Company was obliged to complete its sector in 1889, in order to be in a position to furnish the necessary current in the interior of its perimeter. The company succeeded, but on account of the rapidity with which it had to complete its work, the expenses exceeded the estimate. It was thus led to regard as absolutely necessary the establishment of a secondary station for compressed air in the vicinity of the sector, the central station being too far off. The company consequently determined to create a new station near the Seine, but the installation was delayed for a year, on account of the tardy delivery of the material by the Cockerill Company and others. The Popp Company was therefore obliged, for its electrical installation, to use intermediary machinery in some places. This fact led to a dispute between the company and the City of Paris. The latter body participates in the profits of the Popp Company as far as regards compressed air, while for the laying of the cable, it pays simply a rent to the City of Paris. The City of Paris asks the Popp Company to deduct the compressed air, as if all had been employed in the electric circuits, while the Popp Company holds that during the completion of the works, a great part of the air had been used at a pure loss, and that, moreover, considering the employment of the dynamos, it was impossible to make an exact deduction. While the City of Paris, by its way of seeing, found a profit of 800,000 francs, the company held that the profit was only 200,000 francs, and that there was none calling for division with the city. This question which, in reality, is only a matter of book-keeping, consisting in establishing exactly what should be deducted for the electric sector, has led to long discussions among the directors of the company, and it was these discussions which gave rise to the Bourse rumours which have been interpreted so unfavourably. The development of the Popp Company during the year 1890, though everywhere its attention was directed especially to construction and building, has been very satisfactory. The following figures will show the exactness of the foregoing. The receipts for clocks were 87,000 francs in 1890 and 91,000 francs in 1889. For distribution of motor power, 356,000 francs in 1890 against 241,000 francs in 1889. For lettings, 18,000 francs in 1890 and 17,000 francs in 1889. For supply of electric current, 805,000 francs in 1890 against 653,000 francs in 1889. The working expenses, on the other hand, were 219,000 francs in 1890 against 209,000 francs in 1889. So that the excess of receipts was 1,049,000 francs in 1890 against 804,000 francs in 1889. In January last the receipts again increased, 8,000 francs for clocks being taken against 7,000 francs in 1890; for motor power, 33,000 francs against 27,000 francs in January, 1890; for supply of electric current, 115,000 francs against 77,000 francs in January, 1890. As will be seen, the development of the company is very satisfactory, those interested not doubting that the company will succeed in time in giving normal profits. It is not true that the Popp Company still requires enormous capital, as heavy expenses would only be necessary in order to extend the network, in the same manner as the Berlin electrical companies need more capital for the continued enlargement of their lines.

From another source we learn the following particulars regarding the Popp Company. A year and a half ago M. Riedler made a report on the installation of the Popp works for the transmission of power by compressed air. At that time there was at the Rue St. Fargeau station a steam power of 2,500 horses (Paxman engines); to this, last year, was added a further five Cockerill engines of 2,500 horse-power. This furnishes power for a number of small motors in the city as well as for powerful compressed air motors of 150 horse-power. By this means the electric light was produced at the Eden, Variétés, the Montagnes Russes, &c. The Retiro and Bourse de la Commerce central stations were enlarged, and in the former cold air machinery and refrigerating chambers were fitted up. A large central station at the Quai de la Gare, on the banks of the Seine, was also constructed. From the end of this year this station will dispose of a motor power of 8,000 horses, and it is worked by 24,000 horse-power. On the left bank of the Seine, running from the station works, a compressed air conduit has been laid down, about 16 kilometres in length, formed of cast iron tubes of an inner diameter of 5 centimetres. This conduit joins the inner network of the city, the tubes of which are 3 centimetres in diameter. As to this distribution of power by compressed air in Paris by the Victor Popp process, M. Riedler made a detailed investigation. The steam engines, which were made at Creuzot, and include the latest improvements, are triple expansion, while the St. Fargeau engines are only double expansion. The following figures as to the consumption of compressed air in Paris are of interest as showing its increased employment: In 1888 it was 45,559,699 cubic metres, in 1889 it was 116,544,183 cubic metres, while in 1890 it rose to 180,205,342 cubic metres. This compressed air is important during the night for electric lighting; but the engines are also running all day on account of the multitude of the uses and applications of the power. The engines are used in this way continuously

for 16 hours. In the new engines the compression of the air is done in duplicate; two cylinders out of the three placed for low pressure aspire the outer air, which is driven back into an intermediary reservoir in which it is cooled, the air is afterwards drawn in by the third compressor cylinder and compressed to 8 kilogrammes.

The question naturally arises as to how air under pressure is utilised in motors. There is, of course, a loss of charge in the conduits running from the stations to the motors. This is an important point, and we now quote from M. Riedler's report on the subject: "The essential point in the utilisation of compressed air is the increase of energy of this air by a prior heating. This operation dilates the air while the pressure remains constant, and consequently increases its action or mechanical energy. It is only in the Popp Parisian installation that this prior heating of the air has given results. All previously to that was imperfect, and with no future before it." In mine working compressed air has long been applied, but suitable heating has never been practised, the formation of ice at the escape alone being prevented. In the Parisian installation heaters are used in the shape of metal calorifers furnished with partitions and interior *foyers*. The results are satisfactory; the amount of heat stored in the compressed air by its prior warming is almost entirely transformed into power during expansion in the air motor. From an examination made by Prof. Weyrauch of the direct transmission of the heat of gas from combustion to the compressed air, the degree of utilisation of heat is about six times higher than in boilers.



ELECTRIC WINDLASS.

[FROM OUR OWN CORRESPONDENT.]

THE electric transfer of power has recently met with an interesting application at the coal mines of the Austria-Hungarian State Railway Company.

The lift in question serves to raise the earth from a shaft 250 metres in depth, which is in course of being excavated deeper.

As a primary machine there is employed a series dynamo, driven by means of bands by a 10-horse Tangye engine. The primary machine with the steam engine is placed in a shed close to the entrance of the shaft.

The secondary machine, with the windlass, is in the lowest cross cutting of the shaft, at the depth of 250 metres.

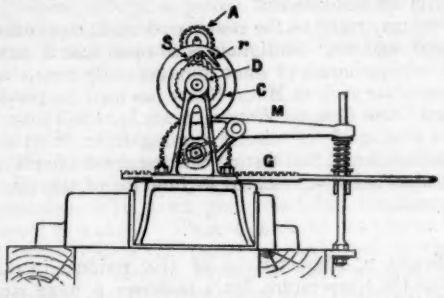
The excavation is now being carried deeper, and the windlass serves to lift the earth, &c., from the lower point—*i.e.*, below 250 metres to the cross cutting. From there it is conveyed further by means of a pneumatic lift, which has been in use for years.

The secondary machine is connected by a spiral movement with the rope drums of the windlass.

The secondary dynamo makes 680 rotations per minute, and the drum 17 rotations. The speed of the rope is 0·6 metre per second. The weight to be transported is at the maximum 250 kilos.

The general arrangement of the installation is to be seen from the accompanying drawings.

As the height to which the earth is to be raised increases with the progressive deepening of the shaft, it is especially important to have an arrangement which interrupts the current automatically as soon as the load has arrived at a certain height.



To render this possible, the windlass is provided with a self-acting check, which can be exactly adjusted at the height required.

This apparatus is shown in the drawing, and its manner of action is as follows:—

The wheel, A, is firmly fixed on the axle of the drum, and catches in the wheel, B. B is keyed upon the spindle, O, which it turns. The wheel, C, is fixed as a nut upon the spindle, O, but does not turn with it, being prevented from rotating by the wheel, E, and by the friction of the disconnecting apparatus.

If the spindle, O, is in motion, the wheel, C, is displaced in the axial direction of the spindle, at the same time carrying round the wheel, E, which is keyed on the shaft.

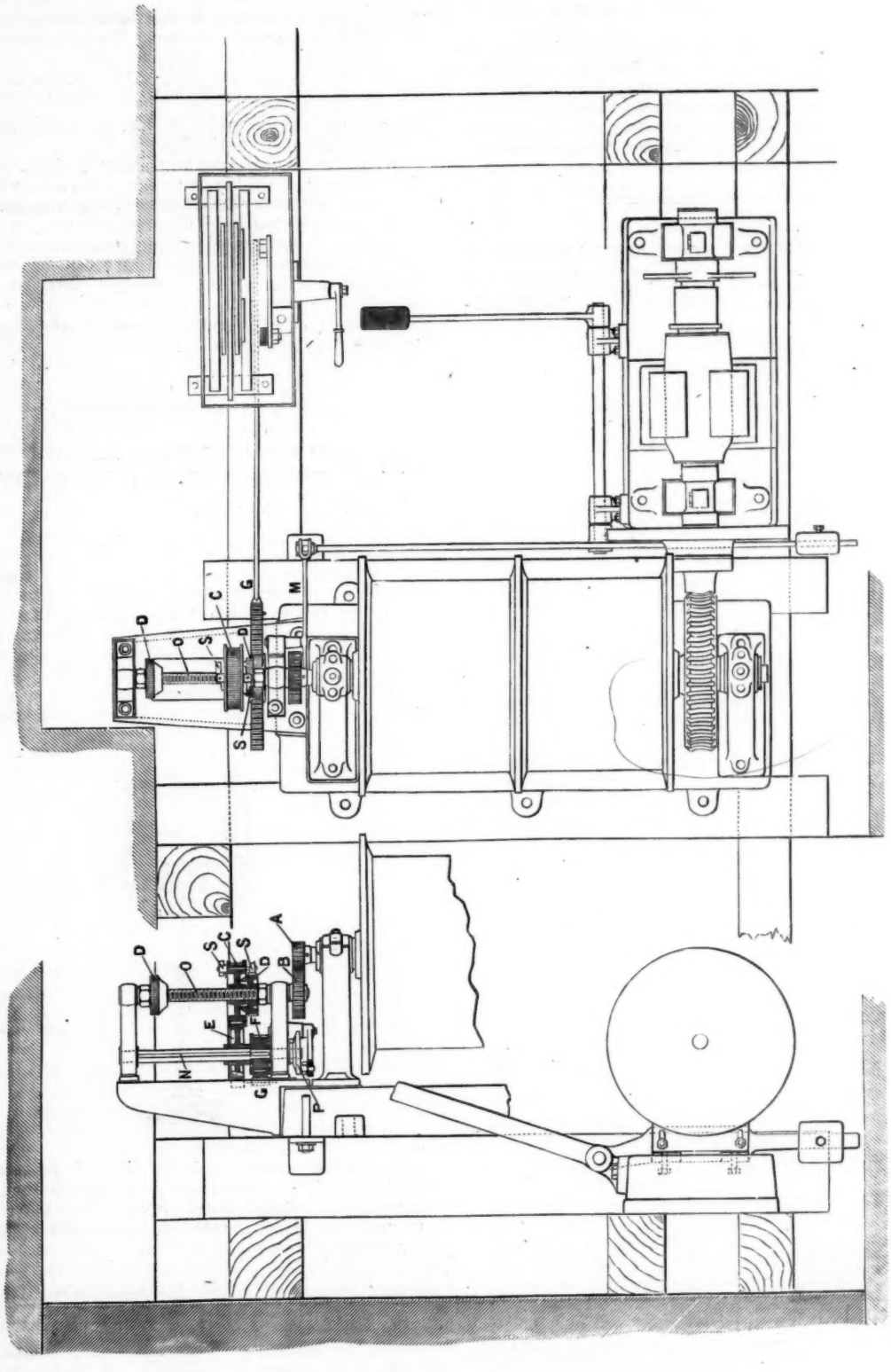
The displacement lasts so long as the catch, S, runs up on the wheel, C, on the cone of the brake-wheel, D, whereon the catch falls into the wheel, D, by means of the spring, *r*, and the wheel, C, is then turned by D, and the toothed rod, G, is displaced by means of the wheel, F.

On the toothed rod there are fixed two adjustable rings, H, H, which run into a fork of the lever, J, carry it with them, displace the lever of the rheostat, introducing successive resistances, and finally interrupt the current of the machine.

At the moment when the toothed rod is displaced, the disc, P, rotates and presses the lever, M, and the connected brake lever down by means of a plug.

The brake is easily introduced and adjusted, and easily brings the dynamo to a standstill, as the mass of the latter is very trifling.

In order to regulate the height, the nuts, D, D, are dis-


D
O
S
C
G
M
S
D
A
B
E
F
N
P

placed, and then fixed in their places by means of the counter-pieces placed behind them.

The accuracy of the adjustment is not affected by the wear and tear of single pieces of the apparatus, as a readjustment is everywhere easily practicable.

As a matter of course, the brake can be easily worked by hand. The connecting conductor is a leaden cable run on porcelain insulators.

It is to be remarked that this installation, which was constructed by the firm Ganz & Co., of Budapest, works under very unfavourable circumstances, as the shaft is very wet, and water constantly penetrates through its sides.

Nevertheless, the installation has worked by day and night since its construction to the full satisfaction of the owners.

THE ADAPTATION OF WHEATSTONE'S BRIDGE FOR THE MEASUREMENT OF RESISTANCES CONTAINING DISTURBING E.M.Fs.

(PRELIMINARY NOTE.)

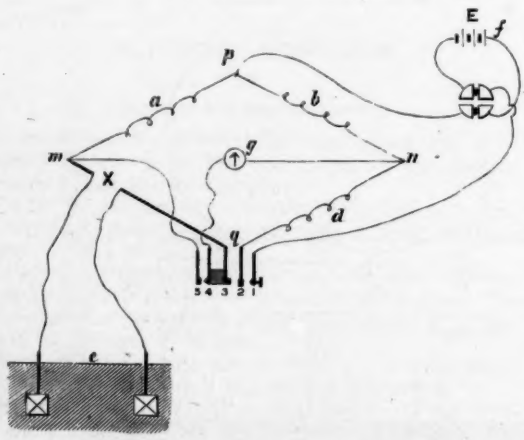
THIS is a method applicable to the determination of the resistance of telegraphic circuits containing earth plates, and to electrolytic and, so-called, "polarisable" resistances. It affords a means, also, of finding the value of the disturbing E.M.F. in terms of the E.M.F. of the testing battery.

If the attempt is made with the bridge in its ordinary form, it will be found impossible to obtain consistent results; for accuracy depends on the E.M.Fs. remaining constant during the whole time of an experiment; this they cannot do when they are able to run themselves down through the ratio arms and the rest of the branches.

Experiment shows that the E.M.Fs. remain practically constant on open circuit, and, corresponding to this constant initial E.M.F. there is an initial resistance, which, for the limits of time required for a test, is constant also.

The object of the following method is the accurate determination of the initial resistance, and, if necessary, the initial E.M.F.

In the figure, a and b are the ratio arms, d the variable, and x the unknown resistance, containing the disturbing E.M.F., e. At q, the meeting point of the battery branch with x and d separate the three branches, and bring a connection from each to the upper three springs of a five-contact key. The lower springs, insulated from the three above, are for the completion of the galvanometer circuit. The conductor



whose resistance is to be measured is, at present, on open circuit. Now adjust the arm, d, to some assumed value of x, and verify it by a single tap of the key. The E.M.F. in the x branch cannot appreciably vary during that short interval, and by a few trials the correct value of d is easily determined. The testing battery is now reversed and a new value, d^1, obtained for the variable arm. For general purposes it will be found sufficient to take the mean of d and d^1 as the initial resistance of x. When a nearer approximation is required the complete formula is

$$x = \frac{a\,(d^1 + d)}{2\,b} - \frac{a^2\,(d^1 - d)^2}{2\,b\,[2\,f\,(a + b) + 2\,a\,b + a\,(d^1 + d)]}$$

where f is the resistance of the testing battery. Let E be the E.M.F. of the testing battery. We have then

$$\frac{e}{E} = \frac{a\,(d^1 - d)}{2\,f\,(a + b) + 2\,a\,b + a\,(d^1 + d)}$$

an expression for the initial E.M.F. of the arm, x, in terms of the E.M.F. of the testing battery.

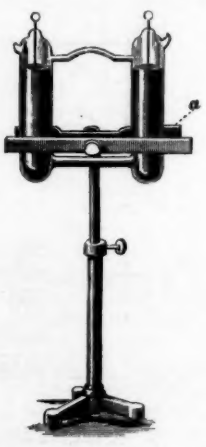
When balance has been very nearly obtained, d being a little too great, if the key is pressed down deliberately there will be a momentary deflection of the galvanometer needle in a direction indicating d too great, followed by a sudden motion in the reverse direction, due to polarisation, indicating d, apparently, too small. We can evidently find a particular value for d at which the first effect just vanishes, and this is the only value of d corresponding to the initial resistance of x. d^1 is then to be determined in a similar manner after reversing E.

ROLLO APPLEYARD.

AN ELECTRICAL METHOD APPLIED TO THE MEASUREMENT OF THE REFRACTIVE INDICES OF WATER.

IN the current issue of the *Berichte der Deutschen Chemischen Gesellschaft* there is an account of some interesting experiments by J. W. Brühl on the refractive indices of water. Until Brühl set to work no measurements of these refractive indices for the hydrogen line H and for potassium light had been obtained; but we notice it chiefly on account of the ingenious electrical apparatus used in obtaining these values.

In obtaining the hydrogen spectrum, Brühl made use of a U-shaped induction tube (*vide* figure), and employed a



strong current so as to obtain the lines of the required intensity. This U-tube is supported upon a stand, and the latter is so constructed and arranged that it will take by means of its clamp, a, tubes of various sizes; this device saves a lot of bother.

The water used was distilled a number of times, the final distillation being made with potassium permanganate; it was also always boiled before every new determination.

Since the violet potassium line cannot be obtained of sufficient intensity to serve for measurement, Brühl resorted to the line in the red, namely, $\lambda = 7{,}700$. Moreover, the

line H_β, $\lambda = 4{,}101$ is nearly coincident with the violet potassium line, $\lambda = 4{,}044$, so that if the former be measured there is no necessity for measuring the latter. The line in the red, $\lambda = 7{,}700$, was obtained by heating a mixture of potassium perchlorate and chloride in the Bunsen flame; this mixture is itself prepared by heating in a platinum dish potassium chlorate until the first period of oxygen evolution is finished.

From the results obtained also for the lithium, sodium, thallium and hydrogen lines, α, β and γ, which have been repeatedly measured by other observers, it seems that Brühl's method is an accurate one. For these and the other results, together with a full description of the method, consult the *Berichte*, xxiv., pp. 644—649.

AUSTRALIAN ELECTRICAL NEWS.

[FROM A CORRESPONDENT.]

THERE has been but little stirring in electrical matters since I last wrote to you. The event which caused most discussion was a notice appearing in the newspapers, "that application is intended to be made to the Parliament of New South Wales during the next ensuing session thereof for leave to bring in a bill to authorise and enable the Australian Gas Light Company to extend its operations to lighting with electricity the streets, &c., &c." This action taken by the Gas Company has been received with marked disfavour by several municipalities. Of late a good deal of discontent with the existing system of public lighting has been manifested among the suburban boroughs. The complaint that the light supplied by the Australian Gaslight Company is altogether too costly to the ratepayers has been so frequently reiterated that the municipal authorities of several of the most important centres of population around Sydney have recently undertaken the consideration of schemes by which to replace gas with electric light. One of the plans suggested was that several neighbouring municipalities should co-operate in the establishment of central works, wherefrom the light could be supplied to each of them according to requirement. This plan has been most vigorously discussed, and is I fancy not yet done with. The largest customer of the proposed co-operative system, Marrickville, has practically decided that electric light it will have, either with or without support from its neighbours. In the first scheme laid down the number of lights for street lighting were apportioned as follows:—Marrickville, 550, Newtown, 400, St. Peter's, 250, Camperdown, 250, and MacDonaldtown, 150.

The contract and agreement (consisting, I am told, of some fifty closely written sheets of foolscap) with all the conditions, &c., attaining to the lighting of the borough of Redfern, was on Thursday, May 14th, finally signed, sealed, and delivered into the hands of the Williamson Electric and Engineering Company. The Council have already spent £750 in the purchase of a site at the corner of Bullanaming and Turner streets for the station. There are at present 400 gas lamps of a nominal 16 candle-power each, and these are to be replaced by an equal number of incandescent lamps of a nominal 25 candle-power each.

The present cost of gas lighting the Redfern streets is £2,100 per year, and it is anticipated that the introduction of electricity will result in a substantial decrease in the lighting rate. It is expected that it will take some eight months to complete the work, but in any case the use of gas cannot be dispensed with until February, 1892.

The completion of the installation of the electric lighting for street illuminating purposes in the municipality of Enfield, was safely accomplished on March 12th, when the official switching on was safely carried out by the mayor amidst much cheering. The Enfield plant is not a large one, consisting of about 50 incandescent lamps, supplied from transformers worked by a Mordey alternator; but on the other hand, Enfield is small itself, and is, moreover, comparatively poor. Up to the present they have not even had gas lamps to light their streets, so the council decided that they would make a commencement, and after considering carefully the cost of the two systems, gas and electricity, decided finally on putting down a small electric light plant, and gradually increase as they go along; consequently, at present, Enfield has about 20 miles of main conductor, and only 50 street lamps. Mr. J. R. Bainton, late of the Gulcher Company, and now with Messrs. Woodhouse and Rawson's Sydney representatives, acted as consulting electrician for the contractors, Messrs. Wood Bros., being afterwards assisted by Mr. E. J. Erskine.

Australia is at all events beginning to recognise the advantages of electricity over gas as a means of street lighting, and the success of the electric lighting experiments undertaken by several country towns and city suburbs has been so decided, that even the Sydney City Council has begun to take real action in the matter, and has asked Mr. E. C. Cracknall, Superintendent of Telegraphs, and Prof. Threlfall of the University, to advise them, and have already done a considerable amount of "thrashing out" various propositions. I understand that it has been virtually decided to form three central stations, and that two sites have been already practically selected. Arc lights will be used almost entirely for street lighting.

There have been various rumours current in Sydney lately about a mysterious electrical contrivance, which only had to be set on a stove to generate sufficient electrical energy to light an ordinary house, and on Friday last, a small party of electricians went out to Hurstville with the purpose of viewing and thoroughly criticising the mystery. Of course it was our old friend the thermopile made on a large enough scale to be deemed practicable for house lighting. Mr. Roberts, the inventor, has his house lit with 8 candle-power lamps, the energy for the illumination of which is supplied by the said thermopile. It is the usual combination, iron and an alloy of zinc and antimony, but the inventor claims for it a novel method of making the junction between the two metals, and also a new method of heating the junctions. The pile that we saw consisted of 720 pairs, each pair being of the usual square-conical shape and having a sectional area of $\frac{7}{8}$-inch square on the internal face and $1\frac{1}{8}$-inch square on the external face. These are all ranged round in circles, one above the other in the ordinary way, forming a hollow cylinder about 3 feet in diameter, and about 2 feet high, in the centre of which is the heating arrangement. On the way down we were told that the consumption of coal was about *5 lbs.* for the 24 hours and that this supplied energy for *12 lights*, and we thought that something fairly good had been accomplished. We ascertained, however, from Mr. Roberts, that the consumption of coal was *50 lbs.* for the 24 hours and that this produced sufficient energy to supply at most *6 lamps* for *4 hours* or about 1 horse-power hour, that is 50 lbs. of coal per horse-power hour, which does not look quite so efficient. On open circuit with the above consumption of coal the thermopile gives 49 volts, but unfortunately it labours under the same disadvantage as its near relation, the primary battery, has a comparatively high internal resistance, 3 ohms, consequently working at its highest efficiency it must have an external resistance equal to the internal—3 ohms. This of course brings down the E.M.F. to 24·5 volts and means that at full efficiency it can only supply six 24-volt 8 candle-power lamps in parallel, and moreover if driven direct all the lamps must be burning together, as, if any be switched off, up goes the E.M.F. To obviate this Mr. Roberts uses storage batteries which he charges during the day and utilises at night. The apparatus does not appear to require much attention, as the fire is never put out, and all that is necessary is to fill up the coal hopper twice a day. A thorough test of its capabilities and efficiency is to be made by Messrs. E. J. Erskine and J. R. Bainton on a thermopile to be erected on the premises occupied by the Woodhouse and Rawson Company in Clarence Street. Mr. Roberts hopes to materially decrease the internal resistance, and should be able to do so, as a recent test made by an officer of the Telegraph Department of seven elements in series gave a resistance of 0·0139 ohms for the seven; which should give but $1{\cdot}43^{\omega}$ for the series of 720. But however much he may reduce it, I fear he will never get it sufficiently low to work direct; as regards the coal bill I will say nothing till Messrs. Erskine and Bainton have completed their tests. But I must confess I do not see that Mr. Roberts's invention is any advance on the thermopiles of Clamond and Arthur Rust, both of whom seem to have investigated very thoroughly the iron zinc-antimony combination.

A series of experiments have been carried out by Mr. J.

Y. Nelson for Mr. Cracknell, with the Cardew vibrator, utilising in the same way as Mr. Langdon Davies's phonophore. At the Easter encampment at Middle Head, the ordinary line was duplexed and diplexed with this arrangement and worked most successfully, especially during a heavy press of work consequent upon the serious torpedo accident which took place. At the encampment telephones were used as receivers, and the transmitters or vibrators were ordinary American pattern Morse relays. Afterwards, a repeater was made out of an ordinary "Watch" telephone receiver, and the signals reproduced very clearly on the sounder. It is proposed to use this method for duplexing some of the country lines.

Experiments have also been carried out with a view of testing the applicability of the Van Rysselberghe system, but at present the system has had but little application owing to the difficulty of adjusting the call bell.

After a protracted struggle between the adherents of cable and electric tramways, the Public Works Committee have decided, by a majority of 7 votes to 5, that the tram to Ocean Street shall be worked by cables, though Mr. Thow, chief mechanical engineer of the New South Wales Railway, who visited America purposely to report on the various tram systems in use there, in his very complete and lengthy report certainly appeared to be strongly in favour of electricity as a motive power.

Mr. Jas. Callender, who has just returned from a trip to New Zealand, has furnished me with some particulars of electrical doings there. He has very kindly given me the accompanying photo, which I send to you, thinking that your readers would be interested in seeing how badly things can be done. It is a photograph of what is intended to be a "safety (?) fuse," taken out of an installation at

Reafton, on the West Coast of New Zealand, by Mr. Meddings, electrical inspector to the Association of Underwriters, of New Zealand, and it was one of many exactly similar. As you will see from the photo it consists of a piece of plain deal shaped with a penknife, and fastened with a couple of wood screws round which the leads were twisted and finally a piece of lead wire twisted round them and covered with a cylindrical tin cover, apparently of the jam-tin persuasion. It was not put in temporarily but as a permanent installation.

Mr. R. E. Fletcher has been very successful in fitting up a plant for transmitting power to the Sand Hills Gold Mining Company on the Shotover River. The mine is about 2½ miles from the river, and the plant is capable of transmitting 70 horse-power. Up to the present, however, 35 horse-power has been sufficient for the work required to be done at the mines, Mr. Fletcher is now engaged on a similar plant at Brunner, also on the West Coast.

Mr. Jones, the electrician to the Union Steamship Company of New Zealand, has just completed the fitting up of the *Rotomahana*, the first boat lighted by electricity, the fitting up of which has been done in New Zealand. There are about 250 lamps in all, supplied by a Westminster dynamo driven by a Robey vertical engine.

The principal electrical work in New Zealand at present is the lighting of mills, in which Mr. Gerald Postlethwaite has had a good share.

ELECTROLYTES AND VAN'T HOFF'S LAW.

It has been noted that those substances which in solution do not conform to Van't Hoff's law of osmotic pressure are all electrolytes, while all substances which are not electrolytes obey the law of osmotic pressures.

Clausius and Williamson, many years ago, suggested that the explanation of electrolysis was to be found in a partial dissociation into their ions of those substances which are electrolysable. Modern research, in defining and confirming their views, has shown that the very partial dissociation which these scientists were thought bold for asserting is in reality anything else but partial. In fact, in the case of those substances which we have been in the habit of regarding as most stable, namely:

Hydrochloric acid	H Cl
Potassium chloride	K Cl
Caustic potash	K O H
Caustic soda	Na O H
&c., &c.,	

the dissociation in solution is almost, if not quite, perfect; water completely, or nearly so, separating the molecules of the dissolved substances into its ions.

So intimate, indeed, is the relation between electrolysis and osmotic pressure, that the latter quantity for any substance may be fully determined from measurements of the electric conductivity of its aqueous solutions.

If this view of the general existence of dissociation in solutions which has arisen out of Van't Hoff's law of osmotic pressures be accepted, many facts hitherto inexplicable receive a *rationale*.

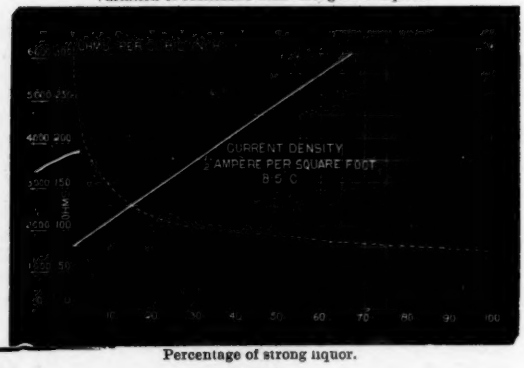
In a recent issue of the *Chemical News* there is an extremely interesting paper by D. J. Carnegie on Van't Hoff's law of osmotic pressures, from which we have abstracted the above remarks; our readers will find in this paper a succinct account of Van't Hoff's recent researches, which may be justly regarded as "epoch-making" in the history of molecular physics.

ELECTRICITY IN THE ART OF TANNING.

II.

A THIRD series of tests was then initiated by Dr. Rideal and Mr. Trotter, the object being in this case to determine the change of resistance produced by diluting the tanning liquor with water. The results of the observation are shown in fig. 2 by the dotted curve. This evidently bears a strong resemblance to a rectangular hyperbola, and on analysing it

Variation of resistance with strengths of liquids.



Percentage of strong liquor.

FIG. 2.

by plotting the relation of the product of the resistance into the strength, with the strength (taking the normal strong liquor of 4·25 per cent. of tannin as 100), the result is a straight line, shown in the diagram, the slope of which is 63, and it cuts the axis of the abscissæ at 1,200. The curve is, therefore, a rectangular hyperbola—that is to say, the resistance is inversely proportional to the strength of the liquor plus the resistance to which the curve is asymptotic; in other words, the resistance of the saturated solution per cubic inch would be 63 ohms per cubic inch.

Hence the formula is

$$r = \frac{120}{s} + 63,$$

where s is the strength of the liquor per cent., 100 being the normal solution referred to.

With a view of ascertaining whether the mechanical stirring of the liquor had any oxidising or other effect upon the liquor, Messrs. Rideal and Trotter next had a vat filled, and the frame kept rotating as in ordinary work, but without any hides, for 24 hours.

Analysis of the liquor before and after this treatment gave identical results as far as the practical point of the percentage of tannin is concerned, thus showing that the stirring has no effect other than that of continually bringing fresh liquor to act upon the surface of the hides.

A similar experiment was made to determine the effect of passing an electric current of ordinary working strength for nine hours through the vat simultaneously with the motion of the frame. At the end of this experiment the liquor contained the same percentage of tannin. This result was to be expected, as the electrical power was remarkably small, and the current density in the liquor far below that of any ordinary electrolytic operation. Taking the mean volts and amperes of the second test already mentioned, and deducting 1·6 volts for polarisation, we have 36·8 watts expended in the liquor. It is obvious that this very small power, about $\frac{1}{27}$th of a horse-power, can have but little effect on 2,000 gallons of liquid. The electrolytic effect is negligible when such weak currents are employed, since a current of 2 amperes will only liberate from water 0·075 gramme of hydrogen and 0·6 gramme of oxygen per hour, or during the whole process considerably less than 10 grammes of hydrogen would be evolved.

In the earlier chemical experiments conducted by Messrs. Rideal and Trotter, their efforts were directed towards establishing the rate at which the tannin is taken up by the hides with and without the use of motion and an electric current. It was also of interest to determine whether the rate of tanning in the circular vats in which the hides were suspended on a rotating frame, was similar to that obtained when a square vat was employed, and the hides suspended upon a frame to which a reciprocating motion was imparted, as already described.

In these experiments the rate of tanning was determined by noting the loss of tannin from the liquor after given intervals of time, and from data so obtained calculating the average rate of loss per hour from the liquor.

The following table summarises the results obtained in three complete tannages in which the process was discontinued at night, so that the electrical current and motion was only applied to the experimental vat for from six to eight hours per diem. :—

TABLE I.

Experiment.	Loss of tannin per hour per 10,000 parts of liquor.	
	Day :—with motion and electricity.	Night :—without motion & electricity.
Circular vat (1) 1,600 gallons	0·62	0·344
„ „ (2) 2,400 „	0·612	0·349
Reciprocating vat	0·533	0·338

The experiments in the circular vat (1) extended over a period of 26 days, during which time the machine was in motion for 167 hours, and a current of electricity applied for 98 hours to the 20 butts tanned in this experiment.

The second experiment in vat (2) lasted for 33 days during 209 hours, of which the hides, 30 in number, were in motion, and a current of electricity passed for 115 hours.

In the reciprocating vat, 40 bellies and 20 shoulders were in the liquor for 27 days, the machine was in motion for 181 hours, and a current of electricity simultaneously applied for 82 hours.

In each of these experiments the hides were completely tanned when they were taken out of the vat, and when finished, were reported to be leather of excellent quality.

Daily temperature readings of the liquor were taken, but on no occasion was the temperature markedly different from that of the surrounding air, 15° C. being the highest reading recorded, and on some days the liquor being as low as 5° C.

The following table gives the actual experimental number obtained in the second of the above tannages, from which the average number in Table I. for this experiment were obtained :—

TABLE II.—CIRCULAR VAT (2.)

Strength of liquor in parts per 10,000.		Number of hours.	Total decrease per 10,000.	Decrease per hour per 10,000.
Machine started.	Machine stopped.			
A.—WITH ELECTRICITY AND MOTION.—(DAY).				
92·8	89·40	5·0	3·40	0·680
93·8	90·00	7·0	3·80	0·540
84·6	81·20	5·5	3·40	0·618
139·2	134·15	8·0	5·05	0·630
127·8	123·05	8·0	4·75	0·593
Average, 0·612 parts per hour per 10,000.				
B.—NIGHT.—AT REST.				
89·4	84·4	14	5·00	0·357
99·4	93·8	15	5·60	0·373
90·0	84·6	14	5·40	0·385
105·6	100·2	14	4·40	0·380
135·8	129·6	14	4·20	0·300
282·2	268·3	45	13·98	0·304
Average, 0·349 parts per hour per 10,000.				

The concordant nature of the above figures, as well as similar ones obtained in the other two experiments mentioned in Table I., at first suggested that the hastening due to the combined action of motion and the electric current was expressed by these numbers. Further experiments, to be referred to later, however, proved that the rate of absorption at night after the action of the electric current had been continued for some hours during the day was much greater than that observed when the hides had not been previously subjected to the influence ; in other words, the increased rate of absorption continued after the machine was stopped and the current was switched off.

This effect may in all probability be attributed to the fact that as the hides pass through the liquor the pores of the skin become distended, and thus facilitate the passage of the liquor through the hides, which remain in this distended state for some time after they are brought to rest and the electric current cut off.

When the machine is at work the heating is further increased by the motion of the hides in the liquor augmenting the frequency of contact of the tannin molecule with uncombined gelatine, and when the current is passing a further heating is no doubt due to the increased motion of the tannin molecules through the liquor which such currents impart to them and its disposition on the suspended hide.

(To be continued.)

DOBBIE'S GEARLESS ELECTRIC LOCOMOTIVE.*

THE prominence that the rapid transit question now occupies in the public mind, renders anything bearing on its achievement of special interest. The needs of the times are fast making the horse car a thing of the past, and even the higher speed of the electric street car falls far short of the actual requirements of to-day.

The impracticability of gears for anything like high speed —for instance, from 30 to 60 miles per hour—and the certainty that, if the armature were placed on the axle direct, the vibration would insure disaster to any known insulation, caused the writer to devise a means by which all the advantages of direct connection could be gained, and at the same time retain the well-known action of springs to obviate or suppress vibration.

My ideas as to how this should be done have been embodied in an arrangement, shown in figs. 1 and 2, in which the desirable combination of spring suspension and direct coupling are attained by the use of a sleeve, H, concentric

* New York *Electrical Engineer.*

with the axle, F. Upon this the motor is mounted—the armature by the usual spider or other device, and the field magnets by bearings, G. At the ends of this sleeve are cranks and crank pins which are coupled to a crank pin of similar radius (in relation to the centre of axle), by a link, L, which assumes a position parallel to the tangent of the armature or wheel periphery. Between the axle and sleeve are interposed rubber or other springs or cushions, to prevent the possibility of the axle striking the sleeve by a severe jolt caused by faults in the track.

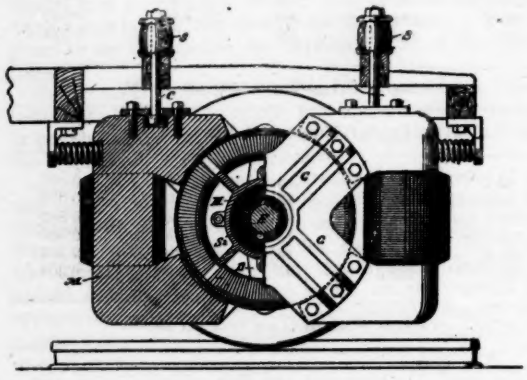


FIG. 1.

This whole system of armature, field magnet, and sleeve, is supported by springs, S S, so that there is no weight placed upon the springs or cushions, s^2, under normal conditions, but in construction of small motors, as shown in Fig. 3, all other supporting springs could be dispensed with, reliance being placed on the rubber springs entirely. In this case, however, cross-tie rods, D′, should be used to counteract the tendency of the field magnets to rotate in a direction opposite to that of the armature. Lateral motion is taken up by springs between sleeve and wheel mounted on the frame so as to act when a lateral strain occurs, as, for instance, in

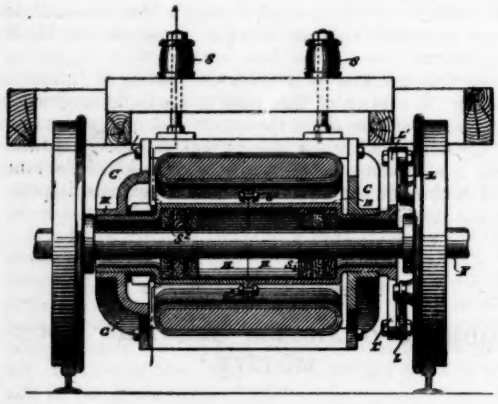


FIG. 2.

going around a curve. Having thus described the principles, it would be interesting to give an outline of the weight, speed and power by an example.

Referring to figs. 1 and 2, these show one motor and a pair of wheels 42 inches in diameter; the armature is 30 inches long by 30 inches in diameter; this being about the largest possible with this size of wheel, and a 4 feet 8½ inches gauge. This is placed in a 4-pole field specially designed with reference to the clearance of the roadway and protection of coils, and connected by bronze castings, G.

Fig. 4 shows another design that has many recommendations. It is of the so-called Kennedy type and is drawn to scale for a 15 H.P. motor on a street car axle, designed to run at 110 revs. per min. Although its weight would be greater than a high speed motor of the usual pattern, the absence of gear wheels with their frames, &c., makes the difference less than would appear at first sight, and this disadvantage is more than made up by the absence of noise and loss in transmission.

Returning to fig. 1, the power of this motor, running at 60 miles an hour (which would be 480 revolutions per minute for the armature), would be 150 H.P., and this could easily be developed. The clearance between the axle and sleeve is 2 inches; the diameter of the axle 6 inches. The

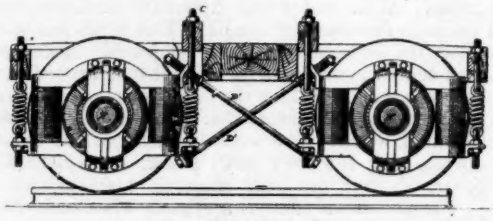


FIG. 3.

whole weight of motor and truck frame is approximately 14 tons (of 2,000 lbs.), and is sustained by journals, F, outside of the wheels. Two such motors on a truck would more than equal the performance of the present elevated railroad engines, and disposes of the many objections to steam locomotives on urban and suburban railroads, so ably pointed out by Mr. Sprague in his paper before the American Institute of Electrical Engineers. A locomotive with two such trucks, weighing about 56 tons in all, and developing 600 H.P., would take the train to Philadelphia in "limited" time.

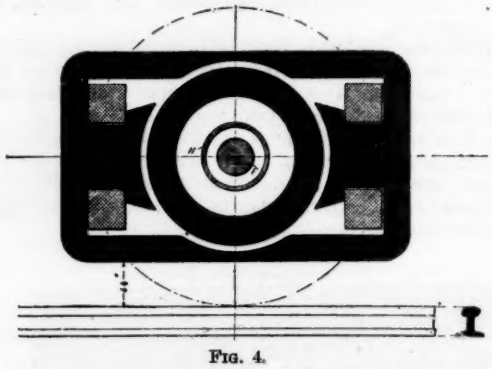


FIG. 4.

There is in this estimate nothing in the nature of an extraordinary motor giving abnormal power for its weight, but it is just a plain statement of possibilities with good electrical engineering of the present day. Upon such a motor a potential of 2,000 volts could be used, and the insulation relied upon, as there would be complete suppression of the small and rapid vibration inseparable with high speed.

It is my conviction that no motor with armature direct upon the axle would stand even 500 volts for 10 hours running at 60 miles per hour with any known insulation that could be applied, and I believe as firmly that a motor suspended by springs, as shown, is capable of fulfilling the more exacting requirements mentioned.

A CARBON FILAMENT IN A TRANSPARENT VACUUM CHAMBER, USED BY DESPRETZ IN HIS EXPERIMENTS ON THE FUSIBILITY OF CARBON BY ELECTRIC HEAT.

BY A. M. TANNER.

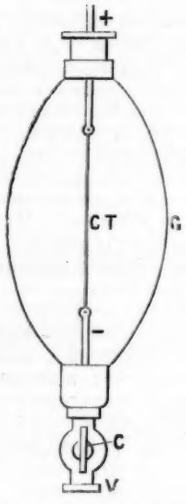
THE object of this article is to prove that Mr. Edison was not the first to "invent" the term carbon filament, and that he was not the first to pass a high-tension electric current through a carbon filament enclosed in a transparent vacuous chamber. I notice that in the great suit now pending in the United States, involving the validity and scope of Edison's principal patent for his incandescent electric lamp, an

eminent lawyer for the defence says, "The question was when did Mr. Edison invent the lamp which depends upon its virtue upon that particular form of carbon to which he has given the undefined and undefinable name of filament."

The writer does not pretend that he is presenting anything new when he calls attention to the fact that Despretz fused and volatilised carbon by electric heat some 40 years ago. Many text books on chemistry and physics make reference to his experiments in this direction.

It is somewhat strange that in the many court suits concerning the validity of the Edison patent in England, Germany, and the United States, no one has called attention to the fact that Despretz used attenuated or very thin carbon, and that he himself gives the term "carbon thread" or "very fine carbon threads" to some of the carbon used in his experiments.

In the *Comptes Rendus* of the French Academy of Sciences for the year 1849, page 709, the Despretz experiments on the fusion and volatilisation of carbon are described in full. In one place he states that a "fil de charbon" is attached to the conducting wires of an electric egg. This arrangement can be shown by the sketch below.



c, cock; c , carbon thread; G, glass tube; v, vacuum pump connection.

In another instance he says that experiments with "fils fin" of carbon were made in a chamber containing nitrogen at a pressure of two or three atmospheres. It appears that Ruhmkorff made the carbon threads, and that the preparation thereof was a very delicate task.

In another part of the article, Despretz says that he "curved and volatilised very fine carbon threads" ("fils très fins de charbon") by a Faraday battery of 60 elements arranged in series. It is also stated that carbon threads were fused and volatilised by the heat furnished by a Bunsen battery of 496 elements, arranged in four parallel series of 124 elements. By reference to any standard French-English dictionary, that of Clifton and Grimaux, for example, it will be seen that the English translation of the French word "fil" is given as "thread or filament." There can be no doubt, therefore, that Mr. Edison was not the first to render a carbon filament incandescent in a vacuous chamber by means of an electric current of a high electromotive force, because from the very nature of things incandescence and luminosity preceded the fusion and volatilisation of the carbon.

The writer does not contend that the Despretz experiments anticipate the modern incandescent electric lamp. They are to be considered somewhat like the Crookes radiometer, which figures extensively in the American suit as possessing all but one of the elements of the combination making up the Edison lamp. Despretz, from the very condition of things, did not have the all glass vacuum chamber and the leading in conductors sealed in the same. Despretz, however, did use a carbon filament or thread attached to leading in conductors and enclosed in a transparent vacuum bulb or a chamber filled with an inert gas.

If Despretz and Ruhmkorff were still living they would be surprised to learn that so much time, oratory, and printer's ink has been wasted in attempting to explain the nature of a carbon filament, a term long before used by Despretz, and that a kind of a monopoly had been set up to the use of the words "carbon *filament*."

Despretz certainly used carbon of great resistance and slight surface, and the expression "very fine carbon threads" cannot mean anything else than "a high resistance carbon filament," which required a battery of a very high electromotive force to send the current through the same.

[If our recollection serves us, the work of Despretz was brought forward in one of the English lamp suits.—EDS. ELEC. REV.].

REVIEW.

The Rise and Extension of Submarine Telegraphy. By WILLOUGHBY SMITH. London: J. S. Virtue & Co., Limited, 26, Ivy Lane, Paternoster Row. 1891.

This work, written by one who has been more intimately associated with the rise and extension of submarine telegraphy than any other person we are aware of, will be read with interest by not only those connected with the "cable world" but also by all those whose pursuits or occupation are in any way connected with electrical or telegraphic matters. Since the early introduction of gutta-percha and its adoption as an insulator for conducting wires, Mr. Willoughby Smith has been connected with the great factory in Wharf Road down to a very recent date, and it is not too much to say that the present high efficiency of this material as an insulator, and its eminent suitability for the purposes of submarine telegraphy, have been largely brought about by the ceaseless and careful attention paid to its manufacture during the whole of the above period by the author, with whose name that of gutta-percha will be always associated.

The rise and extension of submarine telegraphy are practically inseparable from that of gutta-percha, for the improvement in the latter naturally led to the extension of the former, and the further demands for submarine telegraphy were met by the further improvements in the quality and efficiency of the material which experience quickly showed to be necessary.

In the handsome volume before us—which contains nearly 400 pages—Mr. Willoughby Smith relates, with interesting particulars, the first attempt to cross the Straits of Dover with an unprotected gutta-percha cable. This portion of early history is mentioned in several works, but we have here a fuller description, containing matter which will be new to most persons, and which will be found of great value as placing upon record the earliest attempt at submarine telegraphy.

In the preface the author remarks, "It was not my intention to write an amplified history of submarine telegraphy, nor have I done so; I do not consider myself sufficiently acquainted with many of the facts concerning its rise and progress, a knowledge of which is, without doubt, essential to the production of a comprehensive treatise of the subject. I have therefore contented myself with merely setting down in chronological order, where possible, many of the incidents which have come within my personal experience, or have been derived from sources for the accuracy of which I can vouch."

The chronological story of submarine telegraphy as set before us deals principally with those cables of which the core was manufactured at Wharf Road, and in following up this history the reader will notice the slow but certain improvement which took place not only in the manufacture of gutta-percha, but also in the cables themselves; these are items which appear as we progress through these pages, and at the same time, and not less important, will be noticed the gradual improvement in the system of testing, from the observations on a common galvanometer to the more exact methods of recent times.

As the description of one cable follows another the author brings us in contact with those engaged in the earlier and later days of submarine telegraphy, and with whom he was at various times associated. In these details we meet with the names of all those well-known persons who have earned distinction in this particular field, many of whom have unfortunately passed away.

The story of the first Atlantic cable, and of the operation connected with the succeeding cables in 1865 and 1866 is very fully told, and ample details are given of the construction of the cables and the incidents connected with the laying of the same. In fact, a good deal of space is occupied with the doings on board the *Great Eastern* during those eventful periods.

In connection with the manufacture of submarine cables, we must not omit to draw attention to Mr. Willoughby Smith's improvements in the use of "wet-serving," and on this point we quote the author's own words :—"On December 30th, 1860, I first mentioned my 'wet-serving' system of saturating the serving of cables with a conducting material instead of, as hitherto, with an insulating fluid, the core thus served being coiled in suitable tanks supplied with water in such a manner that the core could be under a continuous electrical test, and the pressure of the iron wires on the serving at the lay plate of the closing machine sufficient to force the water into any flaw that might exist in the gutta-percha.

"It was easily demonstrated that tarred hemp concealed faults, while hemp saturated with water immediately developed them. On one occasion the experiment was tried of making in various ways several serious faults, then serving the core with tarred hemp in the ordinary way, and immersing it in water. There it tested as perfect for 2,348 hours, then after twenty-four hours' reversals at the rate of 200 per minute from 100 cells, the faults in some cases developed, but in others neither time nor reversals, so far as could be ascertained, seemed to have the least effect.

"My system was condemned at first by the many who thought tar necessary to the preservation of gutta-percha, but as it quickly manifested its superiority, it became universally adopted."

Of the use of dry hemp as serving, and the effect of water on it, Mr. Willoughby Smith gives some amusing instances. Of the extraordinary effect of water upon dry hemp serving it is difficult to comprehend unless we have actually seen the result.

The method of testing submarine cables during submergence, introduced by Mr. W. Smith, has been well known for some time, and has contributed not a little to the facility of cable operations. A full description of this excellent method, with diagrams and instructions of how to carry on the tests from ship and shore, is contained in the book. Whilst mentioning the matter of testing, we would draw attention to an illustration in the book, copied from a painting by Mr. R. Dudley, of the test room on board the *Great Eastern*, depicting the author announcing the receipt of signals through the recovered portion of the 1865 Atlantic cable. Amongst the numerous forms around, many well-known faces connected with that expedition will be recognised.

We cannot follow the author further through the many interesting details of other expeditions; but in another notice we propose to draw attention to the numerous important facts which are given as to "gutta-percha," and its practical "rise and extension." We, however, cannot help noticing that as regards expeditions where "core" other than that from Wharf Road was used, but few details are mentioned. In the concluding chapter the author remarks: "My experience is that the copper wire, as now made, does not alter mechanically or electrically in laid cables." In this we quite agree; but in a succeeding remark we do not: "I have never seen faults produced by lightning, although I have heard of them;" and the author does not believe in them. We, however, have not only heard of such faults, but have actually seen the results—results of such a nature, that no stretch of imagination would ascribe them to manufacture. Although the author has—*we* say it—done very much towards the improvements in the manufacture of submarine cables, yet he would seem to doubt that much improvement has taken place. Speaking of the great advance in marine engineering, and the speed obtained during the past 40 years, Mr. Willoughby Smith says: "Has the same advancement been made in the manufacture of submarine cables? I trow not; and until the fact is more fully realised that the electrical portions of a cable are as delicate, and require the same amount of care and attention as would be bestowed upon the manufacture of the works of a good watch, it never will be." To agree with the author on this point we consider impossible; after all these years of personal acquaintance with the good and valuable work done by Mr. Willoughby Smith in this particular field and in reading these pages to have again brought before our mind his improvements and the ceaseless work done by him, told in his own modest language, we are bound to confess that great advancement has been made, and in this advancement and improvement we are pleased to think that the author of the "Rise and Extension of Submarine Telegraphy" will—whether he approves or not—be always associated.

We commend the following extract from the *Atlantic Appendix*, p. 384, to the notice of the author as somewhat bearing on this subject :—

> Then send the current through, my dear;
> Come, Willoughby, don't look gloomy, dear,
> For you're the best to try and to test,
> With you no faults will do, my dear.

A CHALLENGE.

IT seems most remarkable, considering the extraordinary development of electric traction in the United States, that such a challenge as Mr. F. J. Sprague makes to the Rapid Transit Commission of New York should at this time find room in an American brain. But Mr. Sprague does many things for "effect," and the present publication, it is to be hoped, for the sake of his countrymen's honour, is only to be regarded in this light. Although the main drift of the resolutions of the said commission was rather favourable to a certain rapid transit scheme for New York city, Mr. Sprague still grasps every opportunity in order to maintain his notoriety, and he declares his readiness to make a demonstration on the following terms :—

Let a section two miles long be provided on the Second Avenue, the Suburban, or the New York and Northern Railway, which shall fairly represent a station section of the express track on the proposed underground road, for use at night when not required for regular traffic.

Set apart a train of six standard elevated cars. These will weigh when empty 71 tons, and carry when crowded to the utmost about 500 passengers, weighing 37 tons, making a net weight of train without motive power of 108 tons.

Let this loaded six-car train be propelled in two ways :—

1. By a separate electric locomotive.

2. By a system of motors, one on each truck, all controlled from a pilot locomotive.

Let the condition of operation be :—

1. A maximum speed of not less than 40 miles per hour on a level.

2. Power to stop the train without the use of brake shoes, and independently of the main station current.

These requirements, both as to weight and speed, are double those now characterising the operation of the London road, and represent a capacity of eight times that mentioned in the criticism.

I will undertake to make this demonstration prior to the formation of a construction company, with free subsequent competition for regular equipment under either of these conditions :

1. The Rapid Transit Commission to require the successful bidder for the franchise to pay the costs of the experiment to an amount not exceeding $50,000.

2. The forfeiture of a like sum, in case I succeed within a specified time, by any person or newspaper that will take up my challenge.

3. On the other hand, entire loss to me if I fail.

4. The time to be four months from acceptance of this proposal, barring labour troubles, with one month leeway, at a forfeiture to me of $100 a day for each day of the month over the four months, and a premium of like amount for every day under four months. If the cost of the experiment shall be less than $50,000, the saving to go to the benefit of whoever pays for the demonstration.

It will be noted that this experiment is entirely at my personal risk, with time limitation, and without any direct pecuniary value to me, but is proposed to demonstrate the soundness of the decision made.

As an evidence of my faith, I am ready to deposit a sum which will guarantee the good faith of this proposal.

This looks almost like a wager, and we hope it will not be accepted. What better proof can be necessary of the advantages of electricity as a motive power than the success, from an electrical point of view, of the City and South London Railway with its 100 H.P. locomotives capable of running 25 to 30 miles an hour. The newly designed Central London Railway, which has received the sanction of both Houses of Parliament, will have electric engines of 300 H.P. capable of giving a high speed.

The elevated railway of Liverpool will be similarly equipped, and is expected to be ready next year. Americans have, then, several practical examples which will serve their purpose better than the proposed *experimental* track.

THE EDISON ELECTRIC LIGHT COMPANY v. THE UNITED STATES ELECTRIC LIGHTING COMPANY.

(*Continued from page* 817.)

ON the resumption of the Court, Mr. DYER continued his argument.

Early in October, 1878, great publicity was given through the daily Press to the announcement that Mr. Edison had discovered an electric light which solved the problem of sub-division, and could be supplied with great economy. Thereupon the question became a matter of discussion, and various men of science, believing that sub-division was impossible, or its accomplishment remote, felt called upon to express their opinion in order to allay the commercial disturbance due to the great depression of gas interests caused by the announcement of Edison's discovery. The deductions of Fontaine were mathematically proved to be correct. Mr. Clarke, a witness for the complainant, has collected many pertinent extracts showing the general acceptance of Fontaine's demonstration and the subsequent mathematical proof. Mr. Preece, a noted English electrician, states that the light with lamps in series decreases as the square of the number, and in multiple arc as the cube of the number. Says Mr. Preece: "It is this partial success in multiplying the light that has led so many sanguine experimenters to anticipate the ultimate possibility of its extensive sub-division—a possibility which this demonstration shows to be hopeless, and which experiment has proved to be fallacious." Similar expressions of opinion were expressed in a letter to *Engineering* in 1878, by Prof. Silvanus Thompson, and by others.

The only experimenter at the time who had any grasp of the essential of sub-divided elecric lighting was Mr. Lane-Fox, an Englishman, who took out several patents. No practical apparatus was made by Lane-Fox. He had a proper appreciation of the general principles, that is, high resistance and small radiating surface, as a means for securing the end, but he made no suggestion for a practical way of attaining those ends; and in the matter of the proper appreciation of the principles it is shown by the brief that Mr. Edison was prior to him; and as far as producing a practical lamp, of course Mr. Edison was first.

In 1879 we have another edition of Fontaine's book. At this time the Jablochkoff candle and arc lamp was in use to some extent, and the ordinary form of arc lamp was beginning to be used commercially. The semi-incandescent or arc incandescent lamps of Reynier and Werdermann were at that time thought to give the highest promise for the solution of the problem of the sub-division of the electric light. The work of Sawyer and Man was carried on contemporaneously with that of Edison, but in the investigation before Mr. Justice Bradley, the conclusion was reached that they were pursuing the wrong principle and did not arrive at success.

Mr. Moses G. Farmer made some experiments on electric lighting. His lamp consists of a globe provided with a rubber stopper at the bottom. Two metallic uprights pass through the stopper, the uprights carrying large carbon blocks at their upper ends, between which is held by spring pressure a small horizontal rod of carbon, the globe to be filled with nitrogen or similar gas, which will not support combustion. This lamp is of no practical use, because the burning lamp expands the gas, forces it out through the stopper, and, on cooling, when the lamp is extinguished, draws in atmospheric air to replace the expelled gas.

It was well known as far back at least as 1845 that when carbon was used in an electric lamp it was necessary to protect it from the oxygen of the air, by enclosing it in a sealed transparent chamber from which oxygen was excluded, in order to prevent its combustion when heated to incandescence. There was no commercial lamp, however, until Mr. Edison put his lamp on the market.

With respect to the work of Mr. Edison upon the subject of incandescent lamps, we have depositions given by him and other witnesses, which were originally taken in the controversy with Sawyer and Man, relating to the invention of the use of the specific material, paper, as the incandescent conductor of the electric lamp. A great deal of this testimony is not relevant here, but from this testimony can be gathered an accurate idea of Mr. Edison's work upon the incandescent lamp, which in addition to statements elicited from Mr. Edison in his examination by the defendants, enable us to make a statement of the course of his work.

It appears that in 1877 Mr. Edison started his experiments upon this subject, made a few experiments, which resulted in showing him that carbon would not have any considerable life under the conditions which he could then command, and he discontinued those experiments, to renew them in the fall of 1878.

We have in the record three sketches of this early period of 1877, showing that even at that time Mr. Edison appreciated the fact that for a multiple arc arrangement of the lamp he needed a high resistance. Those are referred to in the brief.

With regard to these first experiments, Mr. Edison says:—

"I think my first experiments were with heating platinum wires to incandescence. Afterwards, heating carbon paper up to incandescence in the atmosphere. Also, coating the carbon with powdered glass, which, in melting, was to protect it from the atmosphere. Also with powdered silicon. Also in the lamp marked 'Edison's First Incandescent Lamp.' Afterwards, by the passage of current through pieces of boron and silicon, rendering them incandescent. Also silicon and boron placed between carbon points. All these experiments, I believe, were conducted between September, 1877, and January, 1878."

He further says:

"The results of the carbon experiments, and also of the boron and silicon experiments, were not considered sufficiently satisfactory, when looked at in the commercial sense, to continue them at that time, and they were laid aside."

The first incandescent electric lamp which is referred to there—that is simply the name which was given to the exhibit by the counsel who put the exhibit into that interference case—is a piece of philosophical apparatus, common in most laboratories, consisting of a glass globe closed by metal caps, and having a sliding rod through the upper cap, the chamber being hollow and adapted to being connected with an air pump. This piece of apparatus was fitted up with clamps inside of the lamp, and in that piece of apparatus, exhausted by means of the air pump, he tried pieces of carbon and various other materials, with a result which simply served to satisfy him that they were not sufficiently satisfactory when looked at in a commercial sense to continue them at that time.

In August, 1878, he took up the work again. Experiments were made upon the use of carbon brought to incandescence by an electric current under the bell jar of the air pump, the air pump shown to the left of that figure, which he had in his laboratory, this being the complete bell jar of the pump and that the separating part. That air pump was fitted up with a frame for holding a carbon or other burner, and the bell jar being exhausted by the air pump, the electric current was passed through the burner.

Carbon pencils were also formed by rolling up tissue paper covered with tar and carbonising the rolls, and those were used for obtaining the light upon the arc incandescent principle and an apparatus similar to that shown in the patent taken by Mr. Edison. That is the third figure there. He took those small rolls of carbon and used them on the arc incandescent principle. It has no particular relevancy to this matter. It is simply one of his experiments.

The experiments with incandescent carbons under the bell jar of an air pump were hardly more successful than those which had been performed the year before with a vacuum globe, so far as producing a continuous electric light is concerned.

As experiments they were successful, in that they proved to Mr. Edison that carbon was a material too easily oxidised and destroyed to be available under the conditions which he was able to obtain. He therefore suspended his experiments with carbon, and turned his attention to the construction of a lamp with a burner made of a material, such as platinum, which would not oxidise so readily.

Mr. Edison has given us a summary of the experiments leading up to the platinum lamp.

"We, in November or December, 1878, had our vacuum pump placed in order to conduct some experiments on incandescent carbon conductors in vacuo, and we tried a great number of experiments with paper carbons, wood carbons, and carbons made with carbonised broom corn. What we desired at that date, and had concluded as the only possible solution of the subdivision of the electric light, was that the lamps must have a high resistance and small radiating surface, so as to be capable of being worked in multiple arc commercially, and our calculations showed us that the lamp must have at least 100 ohms resistance to compete successfully with gas; otherwise, if the lamps were of low resistance, the cost of the main conductors would be so great as to render the system uncommercial. What is meant here by a subdivision of the electric light is, that many thousand lamps could all be placed upon a single circuit, and be entirely independent of each other.

"We, from our previous experiments, knew that we could get the requisite resistance and small radiating surface necessary for a commercial use of the light by means of carbonised paper or wood; and, therefore, while working to accomplish this end by means of platinum, we endeavoured, by a more perfect vacuum, to obtain incandescent conductors of carbon, which would give us the result.

"But our experiments in November, as before mentioned, with a good pump, wherein we used paper and wood carbons, were not so satisfactory as the experiments we were conducting with the platinum conductors. When we made the carbon in such a form as to have a small mass and high resistance to suit our purposes, it would last but several minutes.

"We then laid these experiments aside and went on with platinum, to endeavour to obtain a lamp of high resistance and small radiating surface."

"*The great point we desired was a lamp of high resistance and small radiating surface, and it did not matter very much whether it was of carbon or platinum.*"

The platinum lamps which he refers to are the platinum lamp of 1878 and the platinum lamp of 1879. Here is a platinum conductor in a globe, not sealed, and a rod passing centrally through it is connected with a lever. The function of that lever is to control the lamp, so that when the heat reached a certain point the regulator would work and cut the current off from the lamp for the moment.

His platinum lamp early in 1879 has a platinum wire wound on to a bobbin and sealed into an all-glass globe. That is the highest perfection that a platinum lamp ever reached, probably; but he still found it desirable to use an arrangement to regulate the current supplied to that lamp.

Notwithstanding the fact that the platinum was in a high vacuum, it was still subject to disintegration, which prevented the lamp being a success.

With respect to the transition from the platinum lamp to the carbon filament lamp of the patent in suit, Mr. Edison testified, in 1881, to the following effect:—

"But when, in the course of our attempts to attain the same objects by means of incandescent platinum, we had procured a Sprengel pump and ascertained we could get exceedingly high vacua, it occurred to me that perhaps a filament of carbon could be made to stand in the sealed glass vessels which we were using, exhausted to a high vacuum, and in October, 1879, we made lamps of paper carbon. In October, 1879, we made lamps of paper carbon and carbons of sewing cotton placed in a receiver made entirely of glass, with the wires sealed therein by fusion, and the whole exhausted by a Sprengel mercury pump to nearly one-millionth of an atmosphere, and these filaments of carbon, although excessively fragile, owing to their small mass, had a smaller radiating surface and higher resistance than we had hoped; *we had reached the conditions where, notwithstanding the carbons were small in mass and filamentary, they were stable;* sufficiently so to allow the economical subdivision of the electric light and the possibilities of competing commercially with lighting by gas. *It was the new conditions which caused this lamp to be a success,* which conditions were high vacuum in a receptacle in which no deterioration or lowering of the vacuum occurred to destroy the carbon.

"These experiments resulted in the lamp and various modifications and forms, more particularly set forth in my Patent 223,898, and in the application now in interference.

Mr. Batchelor, Mr. Edison's principal assistant for many years, gives testimony at length, which is quoted in the brief. I will refer to one or two statements. Referring to the 1878 experiment Mr. Batchelor says:—

"*It had early been decided by Mr. Edison that the requisite material or his incandescent lamp should have a great resistance combined with the least possible surface.*"

There we have the whole thing.

And referring again to the experiments upon the platinum lamp, Mr. Batchelor makes a very pertinent statement, showing the analysis that Mr. Edison applied to this subject. He says:—

"Mr. Edison very frequently sat down at my table and worked for hours helping me on these experiments. *Our conversation frequently was directed to getting the highest resistance in the least possible space. I remember once or twice during these conversations, early in* 1879, *he remarked how easy it would be to get this resistance if carbon were only stable.*"

He knew that carbon was what he wanted, on account of its infusibility, on account of its high specific resistance, but carbon could not be used because it lacked stability; and, says Batchelor, "Mr. Edison often remarked how easy it would be to get this resistance *if carbon were only stable.*"

Mr. Upton, another assistant of Mr. Edison, also testified in this interference case relating to carbonised paper. While there was no occasion for saying anything about a thread lamp or the discovery of the stability of carbon, yet those facts were so firmly impressed in Mr. Upton's mind that he couldn't tell the story with respect to the paper lamp without telling about this discovery of the stability of carbon, and the fact that the discovery was made with a cotton thread lamp, which had nothing to do with that particular controversy at all. He says (Vol. 5, 3,239):—

"I recollect when one of the first successful loops was made. Frances Jehl and I measured the resistance cold of the carbon. My recollection is that it was about 140 ohms. The carbon was burned for a number of hours and again tested and no change found in its resistance. This was repeated several times, burning and testing until the lamp gave out. I remember that *we all felt very much elated* at the fact of the carbon not changing its resistance, *for it showed that there was no wasting away of the carbon.* We then felt that it was possible to make a system of electric lighting simply by adding to the life of the lamp, which we have since done."

And in the next answer he says that that experiment was with a lamp having a cotton thread carbon.

The conditions existing in Mr. Edison's lamp and the advantages of its most important features of construction are found stated by Mr. Edison in his interference deposition of 1881. We cannot restate them better than he has himself stated them, and with your Honour's permission I will read what he says about the advantages of that lamp:—

"But these lamps, in addition to the fact that they lasted for a long time, had other characteristics, without which, even with a long life, they would not have been available for competing with gas.

"These important characteristics were that they were of high resistance, of small radiating surface, and hence economical, for the reason that smaller conducting wires could be used for conveying the current, as owing to the high resistance of the lamps weak currents were only necessary, and sufficient energy to produce the result was forced through the wire and lamps by increasing the electric pressure or electromotive force. If lamps of low resistance were placed in multiple arc in a single circuit, the aggregate resistance of all the lamps would be very low, and conductors of correspondingly large dimensions would have to be used, otherwise a great loss of current in the form of heat would take place on the conductor. Hence, if the resistance of each lamp was made, say, 100 times greater, then the conductor could have 100 times less area, and the losses would be the same in both cases. With small radiating surface less energy is required to produce a candle-power than on a larger surface."

With the old type of lamps, having rods, it became necessary to provide means for the expansion and contraction of the conductor, and also the means of protecting lamps from the heat of the burner. It is quite remarkable that from this small filament of carbon, having a temperature of probably upwards of 2,500°, the slight capacity of that material to conduct heat back to the wires prevents it from delivering sufficient heat to the wires to destroy the seal. Of course, if those small platinum wires were heated by heat conducted back to the burner, they would certainly expand and crack the glass around them, and the vacuum would be destroyed; so that the small filament of carbon permits us to make the simple connection of the carbon burners with those wires, and to seal the wires into the glass and to hold them there.

It appears amply by the testimony put in on behalf of the complainant that there is disintegration going on, even in modern lamps; but it does not go on sufficiently to make the lamps uncommercial, and that there was indeed a practical discovery in so reducing that disintegration and finding how that might be so reduced as to lift the lamp from a failure into a success.

And then it is further shown by the testimony that, as the art stands at present, the lamps are not destroyed by means of disintegration. What it is that brings those lamps to an end finally is not ascertained. Mr. Edison says that he has himself devoted a great deal of time and considerable expense to finding out what is the cause of the termination of the life of the lamps. He has not been able to find that out. Formerly there was no doubt as to the cause. Lamps terminated, and terminated very quickly, owing to the disintegration of the carbon. Now that disintegration only exists as an inconvenience in the slight blackening of the globe, and not as a factor in the final destruction of the lamp.

The defendants may argue that this is only a matter of degree, but surely that which can turn failure into success cannot be so characterised.

Following the cotton thread lamps of October 21st, 1879, and in the same month lamps were made of carbonised paper, lamp black and tar putty, wood splints, &c., all prior to the filing of the application for the patent in suit. Mr. Edison selected thin Bristol board for making the first lamps that were exhibited to the public, and a private view was held in his house early in December, 1879, and towards the end of that month a public exhibition was given, which was attended by thousands of visitors. The *New York Herald* for December 21st, 1879, published a full page article thereon. Thereupon, Mr. William G. Sawyer, the Sawyer of the Sawyer and Man experiments, published a challenge to Mr. Edison to do certain things. One was to maintain the vacuum in the lamp, and another to run his carbonised paper three hours, Mr. Sawyer declaring the carbon will last only 20 minutes in a perfect vacuum.

Actual tests by Profs. Rowland, Barker, Morton, Brackett and others soon confirmed and showed that Edison had produced a durable lamp, and had proved the possibility of subdividing the electric light.

In the spring of 1880, the steamship *Columbia* was lighted by Edison lamps with paper carbons; later in the year bamboo was adopted for filaments, and has been in use for that purpose ever since.

Not until 1881 was the scepticism of European electricians overcome, when, at the Paris Exposition, Edison's apparatus gained diplomas, medals, &c., and finally Mr. Edison received a special diploma of honour, and was decorated by the Government with the rank of officer of the Legion of Honour.

It appears from an official bulletin of April 6th, 1883, that a central station plant had been running in New York city for several months without stopping, day or night. By October of the same year, the station was lighting 508 houses, wired for 12,000 lamps. The business has so grown since, that at a moderate estimate, the number of lamps manufactured daily approaches 100,000, the Edison factory alone employing 1,000 men, and having a capacity of 25,000 lamps per day.

The defendants' experts take the position that, in view of the state of the art, no invention was required to produce the lamp of the patent in the suit. If these experts could not have made a perfect lamp at first the difficulties would soon have removed in practice by application of existing knowledge. These same gentlemen, when the necessity arose in the McKeesport case of making a place in the art for the Sawyer and Man arch-shaped fibrous carbon, treated the prior state of the art as entirely inadequate to supply a practical device. A large gap existed in the art which it was necessary to fill before incandescent lighting could become a commercial fact. Judge Bradley agreed with them that a gap existed, but that the Sawyer and Man patent did not bridge it, but Edison's high vacuum and thin filaments had done so. Now that there is a change of attitude, these gentlemen find no difficulty in disagreeing with their former testimony, and with the decision of the judge, and they say now there was no gap at all. What reliance can be placed upon statements of facts or expressions of opinion given by these experts.

In an article in *Scribner's Magazine*, for August, 1889, while the McKeesport case was under consideration, Dr. Morton said: The problem of commercial electric lighting by incandescent conductors yet remained without a solution. This state of affairs lasted to the fall of 1878, when Sawyer and Man came in and solved the difficulty, but that to Mr. Edison many simplifications and improvements are due, by which the range of use of the lamp has been much extended. If Sawyer and Man had succeeded in the McKeesport case it would have been quite immaterial what improvements Edison had made, but as the decision removed Sawyer and Man from the prominent position given them by Dr. Morton, there is left a beneficial residuum, viz., that the problem remained without solution, and what Edison did was to extend the usefulness of the lamp.

As to Prof. Cross, his opinions vary with a change of client and a change of retainer.

With regard to the construction of the patent, Mr. Dyer said he would briefly allude to the question of the meaning of the term "filament of carbon" appearing in all the claims as descriptive of the lamp burner. The contention, both in the English litigation and the present suit, was, the definition was vague, indefinite, and uncertain; that a determination of the meaning was necessary in order to exclude old lamps and include new lamps. Complainant would contend that so long as defendants' lamps were distinctly of a filamentary character, there would be no reason for a discussion as to how much larger they might be and still be within the terms of the patent. The defendant suggested that a filament should be defined as a burner of at least 100 ohms resistance hot. The object of that contention plainly was this: Under the present affiliation of defendant with the Westinghouse Company, a system had been introduced of distributing electricity by alternating currents at high pressure, which made it possible to use lamps of 50 to 60 ohms resistance, so if defendants succeed in that contention they will be able to pursue their business using lamps under 100 ohms resistance.

Mr. DYER then went into the difference between rods and filaments, comparing the finest filament with a carbon rod of 1 mm. diameter.

So far as the record has been investigated down to the present time, it would appear that Mr. Edison was entitled to a broad claim for the combination of a carbon burner, irrespective of its dimensions, with a vacuum chamber of this particular character. The real scope of his invention was broader than the filament, though that particular form was necessary in order to make it a practical success. The patent is limited to, or describes, that; but on the broader ground of his discovery of the stability of carbon, a liberal construction should be given to his claim.

At the last moment, defendant found that Dr. Isaac Adams had made what they call a lamp, having a carbon burner in such a chamber, years before Mr. Edison made this discovery and invention. This was undoubtedly an absolutely abandoned experiment, and need not be dwelt upon. No sample has been preserved; no publication was made. A patent was applied for in 1882; a rejection was had upon Edison's patent; the rejection was accepted and the claims restricted. Whatever else it might have been, it was a lamp of large radiating surface and low resistance.

In conclusion, Mr. Dyer said that if he had succeeded in clearing away some obstructions in the line of sight, so that argument might henceforth be carried forward with less labour of both court and counsel, his duty would have been successfully performed.

Mr. WETMORE asked whether complainant claimed that the carbon filament of the second claim is one requiring a high resistance irrespective of its specific resistance. Mr. Dyer replied that it meant a carbon conductor of small cross section and great tenuity. Its resistance depended upon its length, which might be longer or shorter. "That is to say," said Mr. Wetmore, "if a filament of great tenuity had only four ohms resistance it would fall within the claim." "I take, it your Honour," said Mr. Dyer, "that this is a discussion wholly irrelevant to this case. Here is the same attempt that was made with our witnesses." "I don't know about that," interposed his Honour, "the question has presented itself to my mind, and I would like to know if my understanding upon that point is correct." Mr. Lowrey said that complainant understood the claims to state explicitly what it was intended to claim. Infringement of the first claim would be claimed wherever there was a carbon filament of high resistance. Counsel had been retained to prosecute these three infringing lamps, but if a categorical question was asked as to whether a filament of 4 ohms was or was not within the second claim, his reply would be that he had not been retained to have an opinion on that subject, and did not know anybody who had. Mr. Wetmore said he did not think his question had been answered. It was a very important point in determining the construction of the second claim. Mr. Lowrey replied that all filaments relatively to their length had a high resistance, which Mr. Wetmore insisted was no answer at all. Complainant's counsel, he said, had drawn a broad distinction between conductors of low and of high resistance. He wanted to know whether that limitation applied to the second claim of the patent, because, neither from anything that had been said, nor from the record, nor from counsel's brief, had he been able to ascertain whether that claim was made or not. Mr. Lowrey said he should ask to have each of the three lamps in evidence convicted under both claims; with respect to the 4-ohm lamp, he was content to wait until the case arose. He was not instructed.

His HONOUR observed that the same question had arisen in his own mind, and he had found difficulty in answering it.

Mr. LOWREY said it was only when the facts were known that the difficulty was perceived of dealing with it except in an actual case. Mr. Wetmore contended that the claim ought to be explicit enough to answer so plain a question without reference to a particular case.

His HONOUR having intimated that he should like further information as to the difference between "series" and "multiple arc" distribution, Mr. Lowrey gave a very clear and felicitous explanation of the matter, in which he was effectively aided by Mr. Dyer, after which the proceedings were adjourned for the day.

(To be continued.)

THE PROGRESS OF ELECTRICITY.

MR. W. H. PREECE, F.R.S., M.I.C.E., electrician of the General Post Office, addressed the members of the Incorporated Association of Municipal and County Engineers at the Institution of Civil Engineers, Great Bridge Street, Westminster, on Friday, on the "Relative merit and cost of gas and electricity for lighting purposes." Mr. T. de Courcy Mead, of Hornsey, president of the Association, presided, and there was a large attendance of members.

Mr. PREECE said: Gentlemen, I have the pleasure this morning of bringing before you the subject of the relative merit and cost of gas and electricity for lighting purposes, and as a practical man, speaking to practical men, I propose to consider the subject solely from a practical point of view, and to deal rather with the financial aspects of the question than the mere technics. Of course I shall have to deal a good deal with figures, and figures are proverbially dry. It has been said that you cannot extract a joke out of figures and that you can always manipulate figures to suit your own particular view. Neither statement is quite true, because we have all of us heard the old story about the two men contesting with each other, and one man saying, "Why, sir, it is as plain as 2 and 2 make 4," and the other man saying, "But 2 and 2 don't make 4; 2 and 2 make 22." And, again as to manipulating figures to suit one's own purpose, I daresay it will be said I am going to do very much that kind of thing myself. But I am addressing you, if I have any prejudice at all, I am addressing you as a gas shareholder, and not as an enthusiastic electrician. Comparisons of cost are generally fallacious, because the comparison depends so very much upon the point of view taken. The questions we have to decide are principally such as these: What is the capital involved in any particular industry; What the profit derived, and what has the consumer to pay? I am not going to bring before you any fanciful figures. They are published figures, they are figures you can get for yourselves, and you will be able to check the deductions I am going to make. Now, I have taken the case of Manchester, for the simple reason that I have more authentic records of what is done in Manchester than I have of what is done in any other town. And for the records of the gas department in Manchester it seems that one ton of coal in Manchester produces 9,611 cubic feet of 20 candle-power gas. I take Manchester also because it is above the average—20 candle-power gas is rather in excess of the average of the country, which is not more than 15. Well, since this is the quantity of gas produced by a ton of coal, it follows that 1 lb. of coal will produce 4·29 cubic feet of gas, and if 4·29 cubic feet of gas is burnt per hour, we get in Manchester an illumination of 17·2 candles. Now, in drawing a comparison between gas and electricity, I must use one technical term, and I think it will be probably the only technical term I shall use, and it is a technical term which is now coming into general use, and will have to be understood by every engineer, whether electrical or municipal, that is the term watt. A watt is the mechanical unit of power. The common unit of work with which we are most acquainted is the foot-pound, and the unit of power we know best is the horse-power, that is the power exerted that will raise 33,000 lbs. one foot per minute. In other words, you may say a horse-power is the power which will raise 550 lbs. one foot per second. The watt is the rate of work done when a current of one ampère flows through one ohm. It enables us exactly to tell you how many lamps will be lighted, and what light they will give. So in the use of electrical energy if we burn in a steam boiler 7 lbs. of coal, we shall get 1·3 horse-power of electrical energy, but represented in watts we shall get 1,000 watts, and 1,000 watts is called a kilowatt. So 7 lbs. of coal will give us a kilowatt hour of energy, and I will show you what light it will give. In the same way as I have shown that 1 lb. of coal distilled into gas will produce 4·92 cubic feet or 17·2 candles of light, so 1 lb. of coal burnt in a boiler to produce steam, will give us electrical energy that will give—I will show it in two forms, one the arc lamp, the other the glow lamp which we use in our houses—1 lb. of coal burnt per hour, and used in electrical energy, if burnt in the form of a glow lamp will give 48 candles, and if burnt in the form of an arc will give 288 candles. So there we start with the first theoretical fact that I bring before you, that 1 lb. of coal distilled into gas in Manchester gives a candle-power of 17·2; 1 lb. of coal, if converted into electrical energy in the form of a glow lamp, 48 candles, and in the form of an arc, 288 candles. That is theoretical. We will now come to hard facts. In Manchester during the twelve months ending March 30th, 1890, the income derived from gas was £434,351, the expenditure was £360,804, showing that in Manchester a balance of £73,549 was derived from gas. That balance was devoted to meeting interest on loans, depreciation of plant, and the cost of public lighting. But from that fact I derive this: that the cost per 1,000 cubic feet of gas to the Corporation of Manchester was 2s., therefore it costs the Corporation of Manchester 2s. to produce 4,000 candles of light. Well, now, I am obliged to use an estimate, for the simple reason that at present the Corporation of Manchester have not established a central electric lighting station. They have obtained a provisional order so as to enable them to do this; and they are now considering whether they shall carry it out themselves or transfer their power to another body. In making an estimate of the cost of electricity in Manchester, we have to take the experience of the cost of manufacturing electricity elsewhere, and on this point there is, perhaps, more reliable, accurate and truthful facts than with perhaps anything else connected with electricity. The Board of Trade exercise such a powerful control over the electric lighting interest that there is no "hankey-pankeying" with the accounts. The accounts of expenditure must show the cost of production, and these are within the reach of everyone. From my own experience of electricity, which is a pretty extensive one, for we have a great many of our post-offices lighted with the electric light, and I have a central station at the General Post-Office, and if you had not your bill full, I should have been tempted to invite you to see what we are doing; we have a very large plant, and we are going to produce in St. Martins-le-Grand sufficient power to light 10,000 lamps, and we are laying down another plant at Coldbath Fields, where we shall generate electricity for another 10,000 lamps; from my own experience I can say that we can produce a kilowatt or Board of Trade unit for 4d. It means that we can produce 4,000

candles of gas for 2s., we can produce 4,000 candles of the arc lamp for 8d., and we can produce 4,000 candles by a glow lamp for 4s. So you see on these facts—I am not calling them estimates, for they are ascertained facts—on these facts the theoretical estimate of light produced is twice as much by the gas lamp as by the glow lamp. These are theoretical estimates they are not practical ones. However proud we, as gas engineers, may be of producing gas of 20 candle-power when you come to the houses and shops of users and consumers you find this 20 candle-power is very considerably diminished. This is a very important question and one which some six or seven years ago concerned us in the Post Office very much, and Mr. Vernon Harcourt, F.R.S. and I devoted considerable time to experiments on this question. Mr. Vernon Harcourt, who is a very painstaking, careful and accurate experimenter, found that the ordinary gas burner, supposed to be consuming 5 feet per hour and giving 15 candle-power really gives only 10 candles, due partly to dirt in the burner, but due principally to the flickering of the light of the gas caused by draughts of air in the room. So while a light burning in a special burner in a laboratory may give 15 candle-power, when you come to a room or passage that lamp will only give 10 candles. This *pro rata* value is equally true of Manchester as of elsewhere. The result is you must add 30 per cent. to the cost of the gas for your 4,000 candles. There is another point, I ought also to say this depreciation in the value of light is not only true in the case of gas, but it is also true to a certain extent in the case of electricity. The lamps when they are still fresh and new will give 16 candle-power light, but after they have been used 200 or 300 hours there is a peculiar effect of the electricity flowing through the carbon filament that causes the carbon to evaporate; it flies away in straight lines, and is deposited on the glass bulb, obstructing a certain amount of light. Again you have a certain amount of dirt and dust collected on the outside, the consequence is you have a depreciation in the amount of your electric light, though not quite so much as in the case of gas. I ought to mention when drawing any distinction between the light-giving, whether electricity or gas, in the light given by each, that 5 cubic feet of gas will give practically 10 candle-power, and 33 watts in its normal power will give you also 10 candle-power. There is one element in gas that is a very serious loss indeed; that is the tremendous waste of gas that occurs through lights being left burning unnecessarily. Persons who have their houses and offices lighted with gas know that servants as a rule go to light all the burners, unless a careful householder goes round and cuts off those that are not wanted. The result is this: from this very element of waste there is 20 per cent. of gas used more than is necessary. It is brought out by this: Taking the nine principal towns in this country, and taking the average number of hours of gas and electricity burnt in this country, the average number of hours of gas is 600, the average number of hours of electricity is 460. This is taken for the average of 200,000 electric lamps which are now alight in London; while in gas you have a tremendous waste from these burners being left flaring, you have no waste from electricity. Electricity is so easily lighted, a tap turns it on and off, that there is a species of instinct that teaches everyone that you only want your electricity lighted in the place where you require it, and the result is you get no waste. The result of it all comes to this that the comparison between gas and the glow lamp is not 2s. as against 4s., which is theoretical, but the practical figure of 3s. 8d. We can prove this. The average amount, taking the returns from the nine chief towns of this country paid per gas burner per annum is 9s., while the average price of gas is 3s. per thousand feet; the average price of the 200,000 electric lamps burning in London is 10s. So we have these two facts that the average price paid by the consumers of gas is 9s. per annum; the average price paid by the consumer to the electric light provider is 10s. This is a rather startling figure, because most people are under the impression that the cost of the electric lamp is very much greater than gas, and I have been myself very much surprised to find that the price I pay in my own house, where I generate my own electricity, and have done so the last eight years was so very small. I find, although I have a gas engine and accumulators, and have over 70 lamps in my house, I am not paying more than when I used gas.

(To be continued.)

NOTES.

Cardiff.—Messrs. Gilbert & Co., Hanway Street, W., have secured the contract for a complete installation at Messrs. Hopkins's Market, Cardiff, with a large number of arc and incandescent lamps.

The Frager Meter.—We omitted to mention when describing this meter that they may be purchased from the International Electric Company, No. 34, Aldermanbury, E.C., or from Mr. R. P. Wilson, 3, Princes Mansions, Victoria Street, S.W.

Projected Italian Electric Railway.—A scheme has been laid before the Italian Minister of Public Works for the construction of an electric railway from Aosta to Pré-Saint-Didier, that is to say, from Aosta to the Helvetian-French frontier. The project, which owes its origin to Signori Farrinet and Garrone, will, if carried out, bring into existence the largest electric railway in Europe. It is proposed to utilise local watercourses as the means of producing motive power.

The Barnet Lighting.—In answer to the paragraph we printed in our last issue relating to the discontinuance of the electric light at Barnet, Messrs. H. F. Joel & Co. say:—"It is true that the Barnet Local Board will very probably resort to gas for the public lighting of their district, for the simple reason that the contract expires on August 31st next; and, contrary to the wish and expectation of the board, we have declined to tender for a renewal of the contract, owing to their breach of faith in refusing to assent to our obtaining a Board of Trade provisional order, which refusal has entailed considerable loss upon us, to recover which we have brought a claim for damages to the extent of £5,000 against the Board. Further, we may add that, owing to the absurd and arbitrary conditions framed by the board, "notwithstanding repeated advertisements for tenders for electric lighting, the invitation has been declined by all responsible firms of electrical engineers." It would appear that the paragraph above referred to was written by a local "gasite," and that there was very little truth therein contained. The first sentence states that the present reversion to gas is the result of a three years' trial of electricity, inferring that electricity had failed, and that a return to gas was accordingly necessary. This was not so. Gas was adopted because no electric light company could be induced to tender under the board's absurd conditions. The cost of the lighting was not dearer than gas, but was some £60 or £70 per annum cheaper than the latter illuminant. Complaint is also made that the electric light was irregular, sometimes going out altogether, but not a word is said as to the fact that the stoppages have been caused, on some occasions, by malicious damage to the leads. It would be hard to blame the contractors for such mishaps, over which they can have no control. One member of the Local Board expresses, in a letter to the *Barnet Times*, his great surprise at the action of the board in completely ignoring their own resolution, passed after serious consideration, in favour of continuing the electric light, and then suddenly, without notice and without rescinding their former resolution, passing another resolution in favour of a contract with the gas company for lighting the town with gas. The Board in their contract with Messrs. Joel & Co. agreed to give them the sole right to the private lighting in the district, and to assist them in obtaining a provisional order to enable them to exercise that right, and this was given as a set off against the undertaking to light the streets by electricity at a lower rate than was paid for gas. If Messrs. Joel & Co. are allowed to proceed with their action and recover damages from the Local Board, which result is not improbable, it will prove a disastrous day for the ratepayers of the district, for besides having to pay an enhanced price for lighting the streets, the unfortunate ratepayers will be saddled with heavy law costs and compensation payment, together with loss of credit to the town through the charge of broken faith brought against its Local Board. For our own part, we hope that it is not too late to settle the matter amicably, and that the lighting be continued to the satisfaction of all parties, and instead of the Barnet lighting being abandoned, we should much prefer to hear that Messrs. Joel and Company were in a fair way to reap some tangible advantage after the anxieties and troubles they have experienced during the past three years.

The Paris Metropolitan Railway.—A scheme for the construction of an electric railway to cross Paris from the east to the west has been added to the project for the making of the long delayed metropolitan in the city.

The Berlin Electricity Works.—The work of constructing the stations of this company for the year, 1890-91, is now finished. The stations in Markgrafenstrasse and Dorotheenstadt are completed, whilst in each of the two others the erection of two large machines will take place during this year. At the same time the distributing system in the inner portion of the town will be transformed into the three wire system. The output of the stations at the end of the year is expected to reach 185,000 lamps. The number of consumers in 1885 was 28; in 1886, 146; 30th June, 1890, 862; 1st June this year, 1,310. The current supplied rose from 24,420,000 ampères in 1889, to 32,268,462 ampères in 1890.

An Electrical Puzzle.—The following letter appeared in the *Engineer* of June 19th. The puzzle seems to be with half the lamps in operation to find the ampères, as the bewildered one does not apparently possess any at half load, but why did he not say whose measuring apparatus he was using?—"Will some of your electrical readers help me in the following difficulty:—I have an alternating electric light plant. The output of the dynamo is 16 ampères at 2,300 volts—that is to say, 36,800 watts, or in round numbers 50 electrical horse-power. The engine indicates very regularly 62 horse-power. The current is let down by a converter in the usual way. The main lead was about half a mile long. It was a temporary cable down for about two months. It was held that this cable was not large enough in view of an extension, and the permanent cable is larger. I was surprised to find the first night we started it that the ampères rose to 23, the volts and everything else remaining unchanged. I indicated the engine, and found to my great surprise that the power was only 68 horse-power. Now $\frac{2{,}300 \times 23}{746} = 70$. So that in effect I was getting considerably over 100 per cent. efficiency. I take it for granted that this arises from the charging of the cable, and is apparent, not real; only the same number of lights were on. I am told they burned a little more brightly than usual. As far as result goes the new cable represents a dead loss. My object in writing now is to ask how I am to measure the true output of the machine, as the watts are evidently all moonshine. With half the lights on, and the engine indicating 38 horse-power, I have no ampères at all.—W. TROTTER, Cawsand, June 15th.

Proposed Electric Lighting at Accrington.—The Town Hall and Markets Committee of the Accrington Town Council have recommended that the Town Hall be lighted by electricity; also that the corporation use its statutory powers in regard to electric lighting in other places.

Motors for Gearless Locomotives.—The first practical application of electric motors being placed upon the driving axle of a locomotive was doubtless that of Messrs. Mather and Platt in the case of the City and South London Railway. The armature is keyed fast to the axle and revolves with it, it has therefore the entire sharp vibrations of the rolling motion transmitted to it. It is well known to railway engineers that a faultless steel axle will have a life in proportion to the number of miles run, or, in other words, to the number of vibrations transmitted to it. Now, since solid steel is subject to such deterioration, how much more must an armature of a motor suffer whose core is built up of many hundreds of thin pieces of iron, and whose winding must also respond to the minute but acute knocks which occur thousands of times per minute. The life, therefore, of such an armature, it would appear, must necessarily be limited, far more limited than the life of a steel axle. Mr. Short, of American fame, some time ago pondered over this question and designed an ingenious arrangement by which the armature, although threaded upon the axle, does not touch it. The armature hub is bored out much larger than the diameter of the axle, and it is supported by independent bearings carried by the field magnet frame. Arms protruding from the hub are connected to the driving wheels by means of links. The motor being supported upon a cushioned base, it seems evident that the flexibility thus obtained will tend to preserve the armature from excessive wear and tear. We reproduce this week an arrangement similar in principle, but varying somewhat in detail, recently published in the New York *Electrical Engineer*.

Tramways Institute of Great Britain and Ireland.—The annual meeting of this Institute was held yesterday, under the presidency of Mr. Carruthers Wain, and was well attended. Considerable discussion arose on Kapp's paper describing the Lineff system, which is now arranged so that the line insulation resistance is greatly increased. Reckenzaun, Sturgeon, Dickenson and others participated in a lively discussion. Jarman read a paper describing his system and exhibited a model car. The general tone of the meeting was favourable to electric traction, but the main question was, will it pay?

Agency.—Mr. Charles A. Smith, of the Athenæum, 71, Temple Row, Birmingham, has been appointed by Woodhouse and Rawson United, Limited, agent for Birmingham and district, and has opened showrooms at the address given, where samples of goods may be seen, as well as local orders executed from stock.

The E. P. S. Batteries.—The Foreign and Colonial Electrical Power Storage Company is now prepared to entertain proposals for the "maintenance" of storage batteries. The term "maintenance" implies the supply and fitting of new material in exchange for old, as and when necessary.

Frankfort Exhibition.—At the recent meeting of the Electrical Section of the London Chamber of Commerce, one of the subjects discussed was the formation of a party to visit the Frankfort Exhibition. It was generally felt that there were greater privileges and facilities afforded in the way of guides, &c., when the visit took the form of a representative party than there would be in the case of a visit as private individuals. The authorities of the Exhibition have been communicated with and have expressed themselves favourably towards the proposed visit, which would probably extend from the 5th to the 15th September.

Bathing Fatality.—On Saturday morning Mr. Mackenzie, the secretary of the Electric Launch Company (late Immisch and Co.) was drowned in the Thames at Hampton while bathing with a friend named Clarke, an electrician, who was on a visit to him at that place. Mr. Mackenzie was seized with cramp soon after plunging into the river from one of the islands, and Mr. Clarke himself was almost drowned in trying to save him. The unfortunate gentleman's body was recovered during the morning, and removed to the Bell Hotel, Hampton, to await an inquest. The deceased was married, and about 40 years of age.

NEW COMPANIES REGISTERED.

Queen Anne's Mansions Lighting and Heating Company, Limited.—Capital £60,000, in £10 shares, of which 3,000 are preference and 3,000 ordinary shares. Objects: To enter into an agreement with W. R. Renshaw, to carry on at Westminster and elsewhere in the United Kingdom, the business of an electric and gas lighting, heating and power company; to erect, construct, lay down, establish, fix, alter, repair, maintain and carry out all necessary and convenient cables, wires, lines, connections, lamps, dynamos, generators, accumulators, pipes, meters, boilers, engines and machinery for generating, distributing and supplying electric light, gas, water, hot air, steam, hydraulic and other power to Queen Anne's Mansions, in the City of Westminster, and to any public or private buildings, streets, or areas in the said city or elsewhere. Signatories (with 1 preference share each), T. E. Huxtable, Birklands, Holland Park Gardens, W.; C. Ince, 102, Alexandra Road, N.W.; W. A. Waterlow, 16, Adamson Road, N.W.; H. P. Dakin, 18, Longley Street, Southwark Park Road, S.E.; E. W. Francis, 91, Manor Park Road, Harlesden, N.W.; H. S. Wood, 54, Cotleigh Road, N.W.; C. R. Pearson, 2, Balfour Terrace, High Road, Leytonstone. The number of directors is not to be less than two nor more than five, the first to be nominated by a majority of the subscribers. Qualification, £300. Remuneration, £200 per annum each, with £50 per annum extra for chairman. Registered on the 25th ult. by Paine, Son and Pollock, solicitors to the company, 14, St. Helen's Place, E.C.

Gloucester Electricity Supply Company, Limited.—Capital, £100 in £1 shares. Objects: To carry on the business of electrical engineers, electricians, engineers, and contractors, suppliers of electricity, manufacturers of electrical apparatus, and mechanical and chemical engineers. Signatories (with 1 share each): E. Garcke, 112, Belvedere Road, S.E.; W. M. Mordey, 112, Belvedere Road, S.E.; R. P. Sellon, 112, Belvedere Road, S.E.; R. Broadhurst, 112, Belvedere Road, S.E.; W. Geipel, 112, Belvedere Road, S.E.; F. E. Andrews, 112, Belvedere Road, S.E.; S. Morse, 4, Fenchurch Avenue, E.C. The regulations of Table "A" mainly apply. Registered on the 26th ult. by S. Morse,

solicitor to the company, 4, Fenchurch Avenue, E.C. Office, 112, Belvedere Road, S.E.

Middlesborough Electricity Supply Co., Limited.—Capital £100 in £1 shares. Objects: To carry on the business of electrical engineers, electricians, engineers and contractors, suppliers of electricity, manufacturers of electrical apparatus, and mechanical and chemical engineers. Signatories (with 1 share each): E. Garcke, 112, Belvedere Road, S.E.; W. M. Mordey, 112, Belvedere Road, S.E.; R. P. Sellon, 112, Belvedere Road, S.E.; R. Broadhurst, 112, Belvedere Road, S.E.; W. Geipel, 112, Belvedere Road, S.E.; F. E. Andrews, 112, Belvedere Road, S.E.; S. Morse, 4, Fenchurch Avenue, E.C. The regulations of Table "A" mainly apply. Registered on the 26th ult. by S. Morse, solicitor to the company, 4, Fenchurch Avenue, E.C. Office, 112, Belvedere Road, S.E.

Stoke-upon-Trent Electricity Supply Company, Limited.—Capital, £100 in £1 shares. Objects: To carry on the business of electrical engineers, electricians, engineers and contractors, suppliers of electricity, manufacturers of electrical apparatus, and mechanical and chemical engineers. Signatories (with 1 share each): E. Garcke, 112, Belvedere Road, S.E.; W. M. Mordey, 112, Belvedere Road, S.E.; R. P. Sellon, 112, Belvedere Road, S.E.; R. Broadhurst, 112, Belvedere Road, S.E.; W. Geipel, 112, Belvedere Road, S.E.; F. E. Andrews, 112, Belvedere Road, S.E.; S. Morse, 4, Fenchurch Avenue, E.C. The regulations of Table "A" mainly apply. Registered on the 26th ult. by S. Morse, solicitor to the company, 4, Fenchurch Avenue, E.C. Office, 112, Belvedere Road, S.E.

Rochdale Electricity Supply Company, Limited.—Capital, £100 in £1 shares. Objects: To carry on the business of electrical engineers, electricians, engineers and contractors, suppliers of electricity, manufacturers of electrical apparatus, and mechanical and chemical engineers. Signatories (with 1 share each): E. Garcke, 112, Belvedere Road, S.E.; W. M. Mordey, 112, Belvedere Road, S.E.; R. P. Sellon, 112, Belvedere Road, S.E.; R. Broadhurst, 112, Belvedere Road, S.E.; W. Geipel, 112, Belvedere Road, S.E.; F. E. Andrews, 112, Belvedere Road, S.E.; S. Morse, 4, Fenchurch Avenue, E.C. The regulations of Table "A" mainly apply. Registered on the 26th ult. by S. Morse, solicitor to the company, 4, Fenchurch Avenue, E.C. Office, 112, Belvedere Road, S.E.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

City of Bath Electric Lighting and Engineering Company, Limited.—An agreement was filed on the 1st ult., dated the 2nd May, 1891, between H. G. Massingham, of Bath, electrical engineer (the vendor), of the one part, and the City of Bath Electric Lighting and Engineering Company, Limited, of the other part (the company), for the sale to the company of the electric lighting and engineering undertaking of the vendor for the public and private lighting of Bath, the exclusive right to use the name of "The City of Bath Electric Lighting and Engineering Company;" the "Bath Electric Light Works," Dorchester Street, Bath, and the plant, machinery, office furniture, stock-in-trade, and particularly the electrical and engineering plant and machinery for the consideration of £31,864 4s. 3d. in cash and 50 fully paid up founders' deferred shares of £100 each. The registered office of this company is situated at the Bath Electric Light Works, Dorchester Street, Bath.

Electric Clean-All Company, Limited.—The statutory return of this company, made up to the 11th September, 1890, was filed on the 1st ult. The nominal capital is £2,000 in £5 shares (of which 120 are founders' and 280 ordinary). Seventy-five shares have been taken up, upon 64 founders' the full amount has been called, and upon the 9 ordinary shares £2 per share has been called. The total amount agreed to be considered as paid on the 64 founders' shares is £320, and the calls unpaid amount to £18. Office, 94, St. Mary Street, Cardiff.

New Zealand Electrical Syndicate, Limited.—The statutory return of this company, made up to the 16th May, 1891, was filed on the 3rd ult. The nominal capital is £30,000 in £10 shares; 955 shares are taken up, upon five of which the full amount has been called, and upon the remainder £1 per share has been called. The calls paid amount to £1,000. Office, Battersea Foundry, Battersea, S.W.

CITY NOTES.

The West African Telegraph Company, Limited.

THE following report of the directors was presented to the shareholders at the sixth ordinary general meeting held at Winchester House yesterday.

The company's revenue for that period amounted to £68,377 19s., against which £21,685 13s. 7d. is charged for ordinary expenses, £4,788 14s. 3d. for expenditure relating to repairs of cables, &c., and £639 8s. 5d. for income tax, leaving a balance of £41,264 2s. 9d. From this amount is deducted £23,693 13s. 4d. (being for interest on debentures £14,027, and for sinking fund £9,666 13s. 4d.), leaving a balance of £17,570 9s. 5d., out of which the directors have placed £6,015 19s. 5d. to the general reserve fund.

The shareholders have received for the six months ending 30th June, 1890, an interim payment amounting to 4s. per share, and the directors now recommend a dividend of 6s. per share, making 5 per cent., free of income tax, for the year ended 31st December, 1890; which, with the appropriation to the general reserve fund of £6,015 19s. 5d., will absorb the balance standing to the credit of the revenue account.

The repairs on the Bolama-Bissao cable have caused an expenditure of £2,092 9s. 1d. The work was well and promptly done. In view of future repairs of this character, it has been deemed expedient to join with the affiliated companies in obtaining the services of a maintenance ship, which will be available at all times for similar work. This involves a cost of £2,500 per annum.

The several sections of the company's system of cables are now in good working order.

The traffic, under the arrangements made with the other companies which form a cable communication around the Continent of Africa, continues to give good results to this company.

The directors who retire by rotation are Sir Henry C. Mance and John Denison Pender, Esq., who, being eligible, offer themselves for re-election.

The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also offer themselves for re-election.

The CHAIRMAN (Sir John Pender) stated that there had been a growth of traffic throughout the whole line, but the revenue had not expanded at the same ratio as traffic for the following reasons: The receipts for telegrams sent from Portuguese stations were guaranteed by the Government to the extent of £41,900. The accounts with Portugal for 1890 showed that they had to claim only £29,455, and judging from the traffic then passing, they would probably have to claim even less for the current year. That increase of traffic placed them in a sounder financial position without however increasing the available revenue, the traffic increase came under the guarantee. Regarding the French stations the case was different. All the money taken at these was in addition to the subsidies received from the French Government, viz., £12,000 per annum. They also benefit by having a share in the revenue derived from telegrams exchanged with the Cape Colony, and other places. The chairman next referred to the expenses, particulars of which will be seen in the report. To add to the comfort of their staff, they had improved the Houses at Conakry, Kotonou, and Gaboon, by fitting new improved jalousies, and they had also found it necessary to supply those and some other stations with more furniture, the total cost of which had been charged to revenue. They had a full year's working, under the agreement with the African Direct Company, of the joint stations, Bonny and Sierra Leone, against eight and six months respectively in the corresponding period. He then referred to cost of repairs to cables, which will also be seen in the report. The retiring directors and auditors were then re-elected, which concluded the business of the meeting.

National Telephone Company, Limited.

THE report of the directors for the year ending April 30th, 1891, states that the accounts show a balance to the credit of net revenue account of £194,821 after providing, among other charges, for the expenses of issuing the new debenture stock, and the accrued interest thereon to April 30th, 1891. Of this amount the sum of £62,973 has been absorbed by the payment of an interim dividend on the preference shares at the rate of 6 per cent. per annum, and on the ordinary shares at the rate of 5 per cent. per annum for the first six months of the year. The directors propose to pay a further dividend on the preference shares at rate of six per cent. per aanum, and on the ordinary shares at the rate of 7 per cent. per annum for the last half of the year, which will absorb a further sum of £86,366, leaving a balance of £45,482. Out of this amount they propose, under article 113 of the articles of association, to transfer to reserve account £40,000, bringing up the amount of the reserve fund to £93,500. There will then remain £5,482 to be carried forward to next year. The extension of the company's business during the last year has been so large that, notwithstanding the heavy reduction of rates which the directors thought it wise to make in the provinces, in view of the expiration of some of the company's

most important patents, the gross revenue, which last year stood at £411,115, reached £418,560 on April 30th, 1891, and is still steadily increasing. The number of exchange and private line subscribers over the whole of the company's system, excluding the south of England district, which last year was 29,257, was on April 30th, 1891, 35,440, an increase of 6,183 subscribers during the year, and the number of subscribers is still increasing. The accrued rental for the year ending April 30th, 1890, was £364,705. For the present year it is £422,378. The working expenses for the year ending April 30th, 1890, amounted to £148,457, being 40·7 per cent. on the accrued rental, whilst the working expenses of this year amount to £184,056, being at the rate of 43·5 per cent. on the accrued rental.

City and South London Railway Company, Limited.

THE adjourned general meeting was held on Tuesday last at Winchester House.

The CHAIRMAN (Mr. C. Grey Mott) said: It will be remembered that at the last meeting held on 18th ult., it was agreed that in the interval the directors should have a conference with some of the larger shareholders in the company, to see if there was any method to be devised for raising additional capital in a better and more economical way than was proposed by the directors, namely, to issue about £50,000 of preference capital. The conference had been held, and the matter had been very fully and carefully discussed, and in the result it was agreed by all parties that the recommendation made by the directors to the shareholders was the best and most economical way of raising the money. It had, however, been proposed to slightly modify the resolution, which quite met the views of the directors themselves, as although they created £150,000 of preference shares, they would be authorised at the moment to issue 5,000 shares of £10 each, that is, £50,000. If more should be required later on, a fresh vote from the shareholders would be asked. It had also been thought desirable that the preference shares should carry with them the ordinary voting powers, the same as ordinary shares have. He therefore proceeded to move the resolution as follows:—

1. That the resolution passed at the general meeting of the company, held August 12th, 1890, relating to the creation of new capital be cancelled, except as to the creation or issue of 5,000 shares of £10. That simply meant cancelling what was done nearly a year ago in creating the balance as ordinary capital before they could create them as preference shares.

Seconded by Mr. HANBURY. Carried unanimously.

2. That £150,000 share capital be, and the same is hereby created in 15,000 preference shares of £10, bearing interest at the rate of 5 per cent. per annum, and the directors be authorised to issue 5,000 of such preference shares as they may think fit. The holders of the preference shares hereby created shall be entitled to vote on the same scale of voting as the holders of ordinary shares.

This was seconded by Mr. HANBURY, and carried unanimously.

A SHAREHOLDER asked if the 5 per cent. was cumulative?

The CHAIRMAN: No.

The CHAIRMAN stated that the shareholders would recollect that the amount that they created was an exceedingly small proportion to their ordinary capital; much smaller than any other railway had.

This terminated the proceedings.

Société Générale des Téléphones.

A GENERAL meeting of the shareholders of this company, and one which eventually proved rather lively, was held at the office in Paris a few days since, to consider the results of the company's working in 1890, M. Lair, president of the managing council, being in the chair. The first portion of the council's report deals with the analysing of the balance sheet which balanced on December 31st, 1890, by a sum of 46,867,867 francs. The profit and loss account for the year's working was as follows:—

	Francs.	Francs.
Profits of industrial establishments and royalties on patents and miscellaneous products		2,013,936.33
To be added, balance from 1889		351,239.07
Total		2,365,175.40

The expenses were as follows:—

	Francs.	Francs.
General expenses...	371,109.58	
Taxes	18,570.75	
Redemptions and reserves ...	962,796.41	
		1,352,476.74
Net Profit		1,012,798.66

After this exposition of the year's working, the report explains the position of the litigation between the company and the State. The company had hoped that the Administration of Posts and Telegraphs would have consented, before opening any appraisement, to settle the questions of principle which divided the company and the State, but the Administration had constituted the appraisement as and from April 1st, 1890. The company, under these circumstances, could only formulate reservations to safeguard its rights. During the month of April last the Administration of Posts and Telegraphs was authorised to pay the company 5,000,000 francs as the price of its network, but a portion of that sum was set against the 1,678,126 francs which had been received in advance by the company on September 1st, 1889. [This was the date of the taking over of the telephones by the State, a full account of which appeared in the REVIEW at the time.] In view of the insufficiency of the payments by the State, and in order to lend its assistance to Compagnie des Télégraphes Sousmarins, the company asked for the opening of a credit with some financial establishments. The company had won its case against those who had infringed the Edison patents. It had claimed from the City of Paris payment of a sum of 1,115,350 francs for rents paid, and the matter was now under consideration at the Council of the Prefecture. Manufacturing at the Bezons establishments was going on satisfactorily, there being a surplus of 199,157 francs over the preceding year's working. The company had entered into a contract with the Compagnie des Télégraphes Sousmarins relative to the construction and maintenance of the lines of that company, and it had guaranteed its capital so long as it continued the construction of its cables. The company had also undertaken the laying of the cables. For that purpose the company had hired special vessels. Two cables connecting Martinique and Paramaribo, and Port au Prince to St. Nicholas, had been laid successfully, and two more remained to be laid. The profits coming from those operations were carried to a separate account. The Calais works, which was opened for the manufacture of cables, had shown very satisfactory results. The council proposed to deduct, out of the 1,012,698 francs forming the profit for 1890, a sum of 33,072 francs for the legal reserve, to distribute a dividend of 18 francs per share, and to carry over 79,625 francs to 1891. M. Vlasto, one of the directors, had given in his resignation on account of his numerous engagements, and the council had not replaced him. In a concluding paragraph, the report calls attention to the late circular of the Administration of Posts and Telegraphs relative to the old apparatus. The company, relying on an agreement concluded with that Administration, had addressed an invoice to all the subscribers, but after the declarations made in the tribune by the Minister of Commerce, these measures were not enforced. After the council's report, some others were read. An animated debate then took place on the subject of the dividend, several shareholders remarking, in energetic terms, that the rumour of a dividend of 27 francs 50 centimes, and even 30 francs had been recently accredited. The surprise was great when, on reading the report, it was found that the dividend would be only 18 francs. These shareholders asked that the 79,625 francs which the council proposed to carry over to 1891 should be distributed, which would enable the dividend for the year to be raised to 19 francs 50 centimes. The chairman and M. May, a director, insisted that the report should not be interfered with. The company was a creditor of the State; it was, on the other hand, a debtor of several financial establishments. There was therefore in the position that which, without inspiring the least disquietude, required prudence. Next year they would be glad of the 79,625 francs carried over. Another shareholder asked if it were true that the State was competing with the company in the manufacture of cables. The chairman explained that the State simply occupied itself with the repair of its lines, and for that purpose even it utilised the company's aid. A shareholder afterwards asked what sum the company reckoned on receiving from the State, and how it would be used. The chairman replied that he could not forecast the result of the litigation now in progress. When the claims of the company had been satisfied, the shareholders would be called together. The meeting, with upraised hands, approved the accounts, and on a scrutiny, the fixing of the dividend at 18 francs per share, which sum was payable as and from yesterday (July 1st). Messrs. Lair, Lebey, and Vinguier, retiring directors, were then re-elected; M. Lazare Weiler was authorised to retain his position as a director, as were Messrs. Lair, May, Wallerstein, and Vinguier, while occupying at the same time a similar position in the Compagnie des Télégraphes Sousmarins; and Messrs. Kulp, de Sainte Marie, and Petit, were re-elected managers.

Babcock and Willcox, Limited.—The prospectus has been issued of Babcock and Willcox, Limited. It states the share capital at £240,000, of which £100,000 is to be in £10 6 per cent. cumulative preference shares, and the balance in £10 ordinary shares. The vendor takes one-third of each class of share in part payment of the purchase money of the European patents and businesses of Babcock and Willcox, water tube steam boiler makers. All the balance of the shares is offered to the public.

The India Rubber, Gutta Percha, and Telegraph Works Company, Limited.—Notice is given that a half-yearly general meeting of the company will be held at the Cannon Street Hotel, London, on Thursday, the 9th inst., at 12 o'clock noon, for the purpose of obtaining the sanction of the shareholders to the payment of an interim dividend, for the half-year ending June 30th, of 5 per cent., or 10s. per share, free of income tax. The company's share register will be closed from the 30th ult. to the 9th inst., both days included.

The Eastern Extension, Australasia, and China Telegraph Company, Limited, have declared an interim dividend for the quarter ended March 31st, of 2s. 6d., per share, tax free, payable on the 15th inst.

St. James's and Pall Mall Electric Lighting Company.—An interim dividend at the rate of 7 per cent. per annum has been declared on the ordinary shares, for the half-year ending June 30th.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended June 26th amounted to £5,653.

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts of the Cuba Submarine Telegraph Company, Limited, for the month of June, were £3,500, as compared with £3,324 in the corresponding month of last year.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 26th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Company were £8,463

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (June 25.)	Closing Quotation. (July 3).	Business done during week ending July 3, 1891. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	98 —101 xd	...	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	45½— 46½	45½— 46½	46½	46
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	84½— 85½	84 — 85	84⅞	83¾
2,809,310*l*	Do. do. Deferred	Stock	11 — 11½	10⅜— 11¼	...	...
130,000	Brazilian Submarine Telegraph, Limited	10	11⅜— 12¼	11½— 12 xd	12	11 9/16
84,500*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	102½	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108	103 —107 xd	...	...
63,416	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅜— 2⅝	2⅜— 2⅝	...	...
63,416	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	1⅝— 1⅞	1⅝— 1⅞	1 13/16	1¾
50,000	City and South London Railway, Nos. 1 to 50,000	10	4 — 5	4 — 5	...	...
$7,216,000	Commercial Cable, Capital Stock	$100	106 —108	103 —107 xd	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	7/16— 9/16	7/16— 9/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	4 — 5	4 — 5	...	...
16,000	Cuba Telegraph, Limited	10	10½— 11½	10½— 11½	10¾	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	17 — 18	18	17⅞
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅜— 10⅝	10½— 10⅝	...	...
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜— 14⅝	14⅜— 17⅛	14⅝	14 9/16
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	...	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 — 110	107 —110	109½	107¾
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 —109	106 —109	107	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14¾—15¼	14¾— 15¼	15¼	15
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	101 —104 xd	...	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	101 —104 xd	101⅜	101½
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	105 —108	105 —108	106½	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	101 —104 xd	105	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	104 —107	101 —104 xd	105½	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —101	99 —101	100½	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	3½— 4½	3½— 4½	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅞— 2¼	2 — 2⅛	2⅛	2⅛
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3 — 3½	3½— 3⅝	3⅝	3⅝
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1½— 1⅝	1½— 1⅝	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅝— 9 7/16	9½— 9⅝	9 11/16	9 9/16
180,042	Do. do. 6 p. c. Preference	10	15 5/16— 15½	15 — 15½	15 5/16	...
150,000	Great Northern Tel. Company of Copenhagen	10	18½— 19	18¼— 18⅝xd	18⅝	18⅝
230,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
9,334*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	10 — 11	10 — 11	...	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	10½— 11½xd	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	18½— 19½	19 — 20	19¾	19¼
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 41	39 — 41	40¼	40
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	7½— 8½	7½— 8½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9¼— 9⅝	9¼— 9⅝	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6½— 7½	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	9⅜— 10¼	9⅜— 10¼	10 1/16	...
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4⅞— 5⅛	5 — 5⅛	5⅛	4 15/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	12¼— 12⅝	12⅝— 13¼	12⅝	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12 — 12½	12 — 12½	...	...
350,000	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	104 —106	103 —105 xd	104½	103⅝
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4½— 5	4 — 5	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼— ⅜	¼— ⅜	...	...
9,000	Reuter's Limited	8	8 — 8½	8 — 8½	7⅞	...
3,381	Submarine Cables Trust	Cert.	114 —118	114 —118	116½	115½
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	4½	...
37,350	Telegraph Construction and Maintenance, Limited	12	46 — 48	46 — 48	47¼	45
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	103 —106	101 —104 xd	...	...
58,000	United River Plate Telephone, Limited	5	2½— 3½	2½— 3½	...	...
146,128*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95 xd	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	95 — 98	95 — 98	...	...
30,000	West Coast of America Telegraph, Limited	10	3½— 4½	3½— 4½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	100 — 105	96 —101 xd	...	...
64,174	Western and Brazilian Telegraph, Limited	15	11½— 11¾	11½— 12	11¾	11 11/16
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 7	6¾	...
27,873	Do. do. do. 5 p. c. Deferred	7½	4½— 5	4½— 5	4¾	...
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	2⅝— 2 7/8	2⅜— 2⅝	2 1/16	2⅜
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10¼	10	...
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	9½— 10½	9 — 10	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	117 —122	117 —122	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —104	100 —104	...	...
42,853	*Westminster Electric Supply Corporation, Ord., Nos. 101 to 42,953	5	4¾—5¼	4¾— 5¼	5 3/16	...

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7¼—7⅜.—City of London Electric Lighting (Pioneer), Shares of £50, £25 paid, 36—37.—Elmore's Austrian Copper Depositing, 1os., 2s.—Elmore's Priorities, 3⅞—4⅛.—House to House Company (£5 paid) 4⅜—5¼.—Liverpool Electric Supply, £3 paid, 2⅝—2⅞.—London Electric Supply Corporation, Ordinary (£5 paid), 2—2¼.—Manchester, Edison and Swan Company, £9 (£1 paid) 2s 6d.—5s.—National Telephone Debentures, 2½—3 prem.—St. James's and Pall Mall Electric Light £5, 5⅞—6⅛.—St. James's and Pall Mall, 7 per cent. pref., ⅜—1 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2½—2⅝.—£5 Preference, fully paid 3⅞—4⅛.—Debentures 90—95.—Wards Electric Car, £10 paid, ⅝—1.

BANK RATE OF DISCOUNT.—2½ per cent. (2nd July, 1891).

A THERMO-ELECTRIC METHOD OF STUDYING CYLINDER CONDENSATION IN STEAM ENGINES.*

BY PROF. EDWIN H. HALL.

THE subject of cylinder condensation is one that possibly would come more aptly before the mechanical engineers than before the electrical engineers, and yet most electrical engineers are to a greater or less extent mechanical engineers, and the time when we can dispense with the steam engine in the practical applications of electricity seems not yet to be near. The methods for turning the energy of coal directly into electric currents, I believe have not yet been put into application.

The subject of cylinder condensation is one that has always been prominent in the study of the steam engine. Before the time of James Watt at every stroke the cylinder was filled with steam and then it was cooled down by pouring water on the outside, or by admitting water into the inside, so that whenever the steam was admitted it found the cylinder cool. A large part of the steam admitted at every stroke was turned into water at once on admission, and some of it was doubtless turned back into steam during the stroke, but much of it went out as water in the end. Watt introduced the independent condenser by means of which the steam is removed from the cylinder without cooling the latter down, as it was cooled before; and yet, it is still believed that a very considerable part of all the steam that enters the cylinder is condensed upon the inner surface of the cylinder; that some of this is re-evaporated during the stroke, but that a very considerable part remains as liquid at the end of the forward stroke, and is only turned back into steam during the back stroke, when it is a disadvantage rather than an advantage, for it has to be expelled by the returning piston. It is considered that in some engines as much as 25 per cent. of all the steam that enters the cylinder goes through the cylinder as water—that is, during the forward part of the stroke.

The cause of cylinder condensation is that when the cylinder is thrown into communication with the condenser, rapid evaporation takes the place of the water remaining on the wall, and that rapid evaporation under the diminished pressure cools greatly the cylinder wall. A little more than two years ago, January 17th, 1889, Mr. Dickerson of New York gave an address before the Electric Club of that city, in which he advanced the proposition that the peculiar character of the indicator card of a steam engine which was supposed to show cylinder condensation and re-evaporation was due to leakage by the valves—leakage in by the valves at one part of the stroke, leakage out by the valves at another part of the stroke. He made the statement that the steamers in the waters about New York city would travel four or five miles an hour with the valve between the boiler and the cylinder closed. Mr. Dickerson's paper excited my interest—perhaps more than it would had

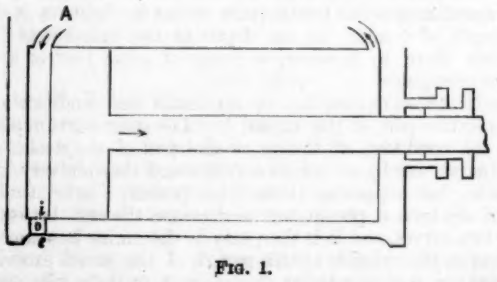


FIG. 1.

I been trained a steam engineer. I knew that this was a matter in controversy between steam engineers—that they were by no means decided as to the amount of cylinder condensation, nor as to what caused the cylinder condensation, some believing that the steam entering at *a*, fig. 1, was cooled by contact with a layer of water remaining over from the previous stroke—the layer of water upon the inside of the cylinder. They thought that you could hardly account, by the action of the iron alone, for the very sudden condensation of such a large amount of steam. Mr. Dickerson's paper, then, stimulated me to undertake an investigation of this matter in a direction in which it had not been approached before, so far as I know. Steam engineers have invariably, so far as I know, examined this question by study of the indicator card, examining the pressure at different parts of the stroke—the pressure and volume, and finding out how much steam they indicate. Knowing the pressure at this part of the stroke, C, fig. 2, and the volume

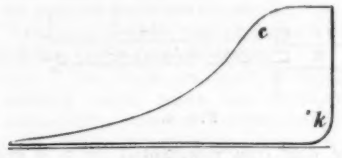


FIG. 2.

occupied by the steam, we can tell what weight of steam there is in the cylinder as steam. It is found frequently that there is more steam in the cylinder at the end of the stroke than at the beginning of the expansion. According to Mr. Dickerson, that was due to the leakage by the valves by which steam was admitted, when the pressure in the cylinder fell low. It seemed to me that we might test the question how much heat enters the cylinder wall by a thermo-electric method. Let fig. 1 represent the thickness of the cylinder wall. o is a hole which, in the engine referred to, is bored for attaching the indicator. It is about $\frac{3}{4}$ of an inch in diameter. The thickness of the wall is about $\frac{3}{4}$ of an inch—a little more than that. I screwed into that hole a plug, fig. 3, having at this end, *i*, a slice of iron —I had steel at first—of known thickness. Into one hole

FIG. 3.

I put a bar of antimony, A; into the other a bar of bismuth, B. The two were insulated from the plug. It is known to all of you that bismuth and antimony make an excellent thermo-electric pair—the best that is in practical use. If I connect the antimony with the copper wire, *g*, the bismuth with the copper wire, *c*, and lead those wires to a galvanometer, I shall get a current through that galvanometer whenever the two junctions here, *a* and *b*, are at a different temperature from the section where the antimony and the bismuth strike this slice of iron. If I put the ends of these rods of bismuth and antimony into a pot of paraffin, and heat the paraffin when I get the temperature of these two junctions, *a* and *b*, where the copper joins the bismuth and antimony, the same as the temperature where the antimony and bismuth strike the iron, the current will cease. If the temperature here is below the temperature there, I get the current in one direction. If the temperature here is higher than the temperature there, I get a current in the opposite direction. That was the beginning of the method. But it presently occurred to me that it would not do to use bismuth and antimony, for the reason that the heat conductivity of those substances was so different from that of iron. My purpose was to find what the temperature was at a certain thickness in the cylinder wall at a certain part of the stroke. (I close this circuit at *g c*, at a particular part of the stroke by means of a cam upon the crank. I can close the circuit at any part of the stroke for a short time).*

It being my purpose, I say, to find what the temperature is at a particular depth in the iron, I wished to have that

* Abstract of a paper read before the American Institute of Electrical Engineers, May 20th, 1891.

* In my latest experiments the flywheel has made about 60 revolutions per minute, and contact has lasted about $\frac{1}{50}$th part of a revolution. The cam pushes two pieces of brass together without touching either of them directly. Springs hold the two slips of brass apart when the cam is not acting.

temperature as exactly as possible what it would be if this iron were in a normal condition, that is, if this were in a solid cylinder instead of being in a prepared plug. To get that I found it necessary to have for these bars, A and B, fig. 3, a heat conductivity which was more nearly like that of iron than the heat conductivity of antimony and bismuth is. So I cast about for some metal which would with iron itself make a good thermo-electric couple, and of which the heat conductivity would be very like that of iron. Nickel suggested itself. Nickel and iron make a very good thermo-electric pair. I determined to make my plug in this way. Fig. 4 shows a plug with a hole bored completely through

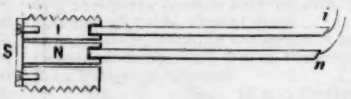


FIG. 4.

it. A slice of cast iron represented by S is ground to a particular thickness, and is screwed on at the end of the plug, making a steam-tight joint—at least I meant it to be steam-tight.* Into this hole I put a core of nickel insulated from the iron except where it strikes the slice. The nickel is soldered to the iron in this way. The slice is tinned very thinly, the end of the nickel core is also tinned. The two are heated, and then in a vice they are held together until they are cooled, so that the thickness of the solder is not more than a thousandth of an inch. The soldering was done with the slice and a nickel core in place, the slice being screwed to the plug, and the core being surrounded with a single layer of paper to keep it free from the iron except at the bottom of the hole. Slice and core were removed from the plug after soldering, and the solder which had been squeezed out from the joint by the action of the vice was carefully turned off in a lathe. The distance from the outer end of the core to the farther surface of the slice was measured carefully before soldering and after soldering. In no case did these measurements show the thickness of the solder to be as much as ·02 mm.

I know very definitely, then, the depth at which the contact takes place. Now as to the heat conductivity of nickel, I can find no data in the books. I believe no information in regard to it turned up in my studies. But I knew from the relation of its electric conductivity to that of iron, that the best conductivity ought to be nearly like that of iron, for usually heat conductivity and electric conductivity go hand in hand. I had to have a bar of nickel made for the experiments. It was a yard long, and about one square inch in cross section. I determined the heat conductivity of that by comparison with a similar bar of cast iron. I found that the heat conductivity of nickel is rather less than that of cast iron, perhaps 15 or 20 per cent. less,† but still nearer the heat conductivity of cast iron than any other metal that I could get that would make with iron a good thermo-electric junction. The specific heat of nickel is near that of iron, which, again, is as important, perhaps, as the matter of thermal conductivity. Now, from the nickel core I lead a nickel wire, both being made from the same bar, of which I had determined the conductivity from the iron an iron wire. This, and the one of nickel, were slender bars about 15 cm. long, rather than wires proper. The junctions, *i* and *n*, fig. 4, are put in a pot of paraffin, and go through the processes which I have indicated already.

I had three plugs made. With one the slice of iron was half a millimetre thick (·051 cm.), with the other a millimetre thick (0·101 cm.), with the other two millimetres thick (0·203 cm.). Let fig. 2 be the indicator card from the engine with which we are making this test. I used first the plug with the thinnest slice, and I found the temperature at this depth of iron half a millimetre at that part of the stroke, *k*, fig. 2, just before steam is admitted. I did the same with the millimetre slice, and with the two millimetre slice. Let D, fig. 5, represent 4 mm. of the thickness of the cylinder wall, points at depths of ½ mm., 1 mm.

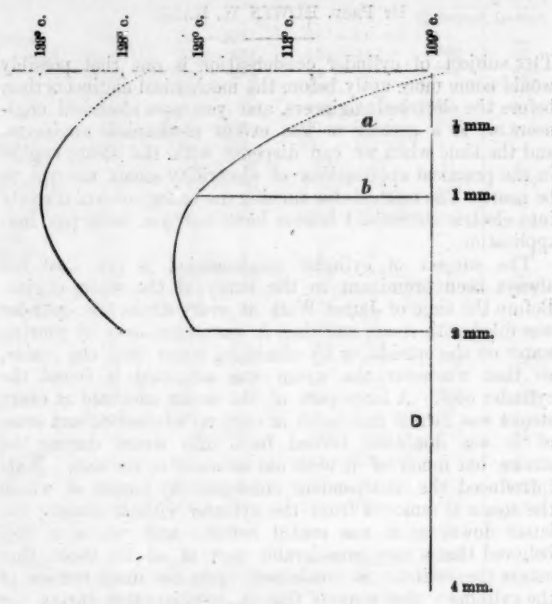


FIG. 5.

and 2 mm. being marked upon it. The curves presented are not perfect. Suppose that distances out here to the left from the line D represent excesses above 109 degrees—109 degrees centigrade being the temperature of the outer surface of the cylinder wall. With the half millimetre slice at this part of the stroke, *k*, fig. 2, I find an excess above 109 degrees of 8 or 9 which I will represent by the distance *a*. With the millimetre slice I find the temperature to be greater at this part of the stroke, and will represent the excess above 109 degrees by the distance *b*. With the two millimetre slice the temperature was not very different from what it was with the one millimetre. Through the tops of the lines, *a b* and *c* I draw a curve. (What I wish to do sometime is to be able to plot a curve like that giving the temperature all the way down here inside the wall of the cylinder at this particular part of the stroke.)

I make similar determinations for that part of the stroke, *c*, fig. 2. I find the temperature at half a millimetre depth has risen to 131 degrees more or less. The temperature at a depth of a millimetre is a little higher. This point half a mm. deep, has already begun to cool. The fact is that in my engine the cut-off is like that (fig. 2)—pretty gradual, so that re-evaporation very likely begins before the cut-off is complete. I suspect, however, that 131 degrees is too low for the temperature at a depth of half a mm. At the depth of two millimetres the temperature is not as high as it is at a depth of 1 mm. At the depth of two millimetres in the iron there is, however, a jump of some four or five degrees centigrade.

One of these curves, fig. 5, represents the condition of things at this part of the stroke, *k*. The other curve represents the condition of things at that part of the stroke, *c*. The curves are by no means accurate and they are very incomplete, but supposing them made perfect, I have merely to put on here a planimeter to measure the area between those two curves, and it is then easy to determine how much the heat in the cylinder at this part, *c*, of the stroke exceeds the heat in the cylinder at that part, *k*, of the stroke, and this excess of heat is the heat which has been given up by steam to the cylinder-wall, which has been done during the admission. Allowance should be made, of course, for the loss through the wall meanwhile. Then I compare that with the indicator card, and see whether the two are in agreement.

I have made some tests for points at other parts of the stroke. I found, as I have already stated, that at a half millimetre depth the temperature at cut-off has already passed the maximum, that it falls rapidly down here during

* In some of the experiments this joint was not perfectly tight, for water was sometimes seen to come out by the core, K, before the plug become hot. Generally on such occasions the leakage appeared to cease when the plug became hot. The fact probably is that the joint continued to leak slightly, but leaked dry steam, the temperature at the outer end of the plug being about 109° C., and at the inner end considerably higher. Both experiment and reason indicate that the effect of such leakage upon the temperature found was slight.

† The nickel used was of fair commercial quality. I am not yet prepared to publish details of the measurement of its conductivity.

expansion, and at this part of the stroke near release it is only a few degrees higher than at the end of the exhaust. But the parts deeper in the cylinder are of course slower to cool. In fact, the heat rushes into the wall here during admission; then as soon as the pressure is relieved the water begins to evaporate from the inner wall here, and the heat ebbs back, and is spent, some part of it, in forming steam during the expansion, but not all of it; a considerable part remains at the end of the stroke, to be spent in evaporating water, which is still clinging to the wall of the cylinder. As I have said, this research is by no means complete, but it has gone far enough to indicate that a very large quantity of heat goes into the cylinder wall. A very rough calculation from my experiments indicates that in the engine I am using, Kendall and Roberts's 10-inch cylinder with 15-inch stroke, this maximum pressure I get here. Fig. 2 is about 33 lbs. above atmospheric. I use an expansion of about 4 and about 60 strokes to the minute. According to the best estimate I can make, probably two-thirds as much steam is condensed upon the cylinder wall as remains active at the beginning of expansion. I should say that two-fifths—this is very likely an overestimate, perhaps one-third would be safer, probably—of all the steam that enters that cylinder is condensed upon the cylinder wall upon the first quarter of the stroke. How much of that is re-evaporated during the stroke, and so helps more or less, I do not yet know. According to the indicator cards taken during the experiments with the plugs, the weight of steam in the cylinder at the end of expansion is about 1·25 times as great as just after cut-off. How much heat is absorbed by the layer of water which remains over from the previous stroke I cannot tell. I think there is some evidence that a layer of water does remain over from the previous stroke. This examination shows, however, that the iron is exceedingly effective in cylinder condensation, and it suggests the question whether it is not possible to coat the inner wall of the engine with something which would prevent to a considerable extent this condensation. It is not easy to find something with which one can coat the rubbing surface of the cylinder, I suppose, but there is the end of the cylinder and there is the face of the piston, and those two surfaces make, in the case of a short cut-off, perhaps more than half the area which is effective in this cylinder condensation. It doesn't seem to me at all impossible that some comparatively non-conducting material can be found with which those surfaces can be coated so as very materially to decrease the cylinder condensation. Experiments for that purpose could easily be made with plugs of this kind. Instead of having to coat the whole cylinder, one might lay on this plug some non-conducting material and see how much difference that would make in the amount of heat absorbed. I haven't attempted anything of the kind, but it doesn't seem fanciful to imagine that something valuable might come out of it, and a very large saving in the steam used in steam engines might perhaps be made in this way.

The research of which I have here given an account has been carried on with money from the Rumford Fund of the American Academy of Arts and Sciences.

For indispensable assistance in the investigation I am indebted to Messrs. Barron, Curtis, Hale, Kendrick and Sage, members of a class at Harvard College engaged in a study of the steam engine.

DISCUSSION.

Dr. W. E. GEYER: I know of some experiments where an attempt was made to effect that saving of which Prof. Hall speaks, by using bismuth in parts of the cylinder. Bismuth is a metal having an extremely low conductivity of heat. Under the circumstances bismuth would not stand; it would gradually grind away, or be torn to pieces and would clog all the apparatus.

Prof. NICHOLS: I am not capable of discussing this paper from the standpoint of the steam engineer, but from the point of view of applied physics it is an exceedingly interesting paper, both on account of the line of work and the method employed and on account of the light which this method seems to throw upon the problem of heat in metallic walls. I would like to ask Prof. Hall whether in his opinion something like lag is to be looked for in the performance of a thermopile on this method. Of course this thermopile is subjected to rather rapid changes of temperature at its junction. To what extent must its sluggishness be taken into account in interpreting the indications of the galvanometer, or does not that enter at all? I have often thought that this must be a factor which we should take into account in attempting to measure fleeting heat values at the junction of any thermopile. I have never looked into it in detail.

Prof. HALL: As the thermopile is ordinarily constructed there would be decidedly a lag. A thermopile is ordinarily constructed in this way: There is one bar of antimony; here is the bismuth; and the two are soldered together for an indefinite distance. If you apply heat to the ends you do not know what you get; that is, if it is a fleeting thing, as you say. But you see what I have. I know what my junction is. There is a definite surface of contact, save for the very thin layer of solder already mentioned. When the heat strikes that I do not see how there can be any lag.

W. J. HAMMER: Would any advantage come from the electrical welding of the contacts there?

Prof. HALL: No; I do not think there would. I think electrical welding would make the thickness of the iron uncertain somewhat; I suppose the pressure you would have to apply might change it somewhat. I have a plug which I propose to try which shall not be soldered—the nickel core being simply held by pressure against the iron slice—to see what difference I shall get between this plug and the others.

GEO. G. GROWER: I would like to ask if it would not take an appreciable time for the heat to penetrate a depth of metal of half a millimetre, a millimetre, or two millimetres. I should think there would be an appreciable interval of time of penetrating that depth of metal, so that instead of getting the temperature at the portion of the stroke expected it might be at an advanced portion of it.

Prof. HALL: What I want to know is not the temperature at the inner surface, but the temperature at my junction. The lag (in one sense) is the very thing I am investigating. I test that for different depths. If I know what the temperature is at a certain depth at one part of the stroke and what the temperature is at the same depth at another part of the stroke—if I can tell how much heat has gone into the iron between one part of the stroke and another part of the stroke—that is all I want.

PROCEEDINGS OF SOCIETIES.

Physical Society, June 12th, 1891.

Prof. W. E. AYRTON, F.R.S., President, in the chair.

Mr. W. H. Dines, B.A., was elected a member of the Society.

Prof. W. G. ADAMS then took the chair whilst Prof. Ayrton read a paper on ALTERNATE CURRENT AND POTENTIAL DIFFERENCE ANALOGIES IN THE METHODS OF MEASURING POWER, by himself and Dr. SUMPNER.

In a paper read before the Society in March last, the authors pointed out that for every method of measuring power in which readings of volts and ampères were taken, other methods in which ampères were read instead of volts, and volts instead of ampères, could be devised. More recently, Dr. Fleming had, by a transformation of a formula given by the authors in a communication made to the Royal Society on the measurement of power by three voltmeters, given the analogue in which three ammeters were employed. The two arrangements are represented in figures 1 and 2, whilst fig. 3 shows a modification of Dr. Fleming's method (fig. 2), in which the current in the non-inductive resistance, r, is measured by the aid of a voltmeter, v, across its terminals. This obviates the necessity of putting an

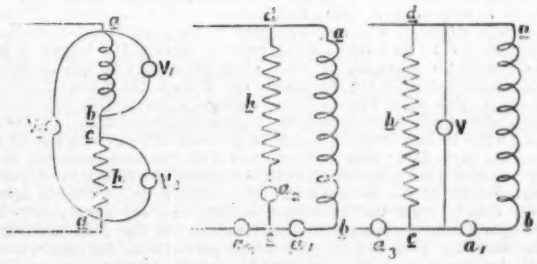


FIG. 1. FIG. 2. FIG. 3.

electro-magnetic instrument in what should be a non-inductive circuit. The formula for the mean watts spent in the circuit, a b, figs. 1 and 2, are respectively

$$w = \frac{1}{2}\frac{1}{r}(v_3^2 - v_1^2 - v_2^2) \text{ and } w = \frac{r}{2}(A_3 - A_1^2 - A_2^2)$$

Mr. Blakesley's method of measuring power by a split dynamometer was shown to be analogous to the original electrometer method in which the difference of two readings was proportional to the power, and Blondlot and Currie's double electrometer method was shown to be the analogue of the ordinary wattmeter. The wattmeter was defective in the fact that a solenoidal coil was inserted in a nominally non-inductive circuit. The error thus introduced is, as was shown by one of the authors some years ago, expressed by the formula—

$$\frac{\text{Apparent watts}}{\text{True watts}} = \frac{1 + \tan\theta \tan\phi}{1 + \tan^2\phi}$$

where θ is the phase angle between the current and E.M.F. in the circuit in which the power is to be measured, and ϕ the phase angle for the approximately non-inductive circuit. It is now proved that the same formula expresses the error in any of the methods where resistances not wholly non-inductive are used.

As is well known, Mr. Blakesley has applied his split dynamometer to the measurement of phase differences between two currents; and an analogous method of finding the phase difference between two potential differences is described in the paper. In this method a high resistance split dynamometer, such as suggested by Mr. Rimington for measuring power, is employed. Blondlot and Currie's double electrometer could also be used for the same purpose. Numerous diagrams illustrating the various analogues accompany the paper.

Prof. S. P. THOMPSON enquired whether hot-wire voltmeters could be employed to measure the various potential differences, without introducing error.

In reply, Prof. AYRTON said that although no great error was introduced by the self-induction of these instruments, yet the fact that they required considerable current was a disadvantage, and as these currents were not always in the same phase as those in other circuits, troublesome corrections were sometimes necessary. Electrostatic instruments were preferable.

Prof. ADAMS said he was glad to hear the inductance of Cardew voltmeters introduced no serious error, for they were very convenient instruments to use.

Prof. O. LODGE, F.R.S., exhibited and described, "A CLOCK FOR POINTING OUT THE DIRECTION OF THE EARTH'S ORBITAL MOTION IN THE ETHER."

After mentioning the various motions to which a point on the earth's surface is subjected, he pointed out that the orbital motion was the largest component and its direction at any instant not easy to conceive. An apparatus for pointing out this direction was therefore convenient when dealing with problems requiring a knowledge of the motion of a point through the ether. In one of two clocks shown, one spindle representing the earths polar axis and another the axis of the ecliptic were inclined at an angle of 23½° and coupled by a Hooke's joint. The latter axis was capable of rotating round the former. At its upper end the ecliptic axis carried a tube and a pointer, both being perpendicular to the axis and to each other. The clock keeping solar time rotated both axes, and when properly set, the tube pointed in the direction of the sun, and the pointer therefore indicated the direction of the earth's orbital motion.

SOME EXPERIMENTS WITH LEYDEN JARS, were then shown by Dr. LODGE. The first one was with resonant jars in which the discharge of one jar precipitated the overflow of another, when the lengths of the jar circuits were properly adjusted or tuned. The latter jar was entirely disconnected from the former and was influenced merely by electro-magnet waves emanating from the discharging circuit. Lengthening or shortening either circuit prevented the overflow. Correct tuning was, he said, of great importance in these experiments for a dozen or more oscillations occurred before the discharge ceased. The effect could be shown over considerable distances. In connection with this subject Mr. Blakesley had called his attention to an observation made by Priestly many years ago, who noticed that when several jars were being charged from the same prime conductor, if one of them discharged, the others would sometimes also discharge, although they were not fully charged. This he, Dr. Lodge, thought might be due to the same kind of influence which he had just shown to exist. The word *resonance* he said was often misunderstood by supposing it always had reference to sound, and as substitutes he thought that *symphoning* or *symphonic* might be allowable.

The next experiment was to show that wires might be tuned to respond to the oscillation of a jar discharge just as a string could be tuned to respond to a tuning fork.

A thin stretched wire was connected to the knob of a jar, another parallel one to its outer coating, and by varying the length of an independent discharging circuit, a glow was caused to appear along the remote halves of the stretched wires at each discharge. Each of the wires thus acted like a stopped organ pipe, the remote ends being the nodes at which the variations of pressure are greatest. By using long wires he had observed a glow on portions of them with the intermediate parts dark; this corresponded with the first harmonic, and by measuring the distance between two nodes he had determined the wave length of the oscillations. The length so found did not agree very closely with the calculated length, and the discrepancy he thought due to the specific inductive capacity of the glass not being the same for such rapidly alternating pressures as for steady ones. He also showed that the electric pulses passing along a wire could be caused (by tuning) to react on the jar to which it was connected, and cause it to overflow, even when the distance from the outside to the inside coating was about 8 inches. During this experiment he pointed out that the noise of the spark was greatly reduced by increasing the length of the discharging circuit. The same fact was also illustrated by causing two jars to discharge into each other, spark gaps being put both between their inner and outer coatings so as to obtain "A" parks and "B" sparks. By putting on a long "alternative path" as a shunt to the "B" spark gap, and increasing that gap, the noise of the "A" spark was greatly reduced. He had reason to believe that the "B" spark was a quarter phase behind the "A" spark, but the experimental proof had not been completed.

He next described some experiments on the screening of electromagnetic radiation, in which a Hertz resonator was surrounded by different materials. He had found no trace of opacity in insulators, but the thinnest film of metal procurable completely screened the resonator; cardboard rubbed with plumbago also acted like a nearly perfect screen. In connection with resonators, he exhibited what he called a *graduated electric eye or an electric harp*, made by his assistant, Mr. Robinson, in which strips of tin foil of different lengths are attached to a glass plate, and have spark gaps at each end which separate them from other pieces of foil. One or other of the strips would respond according to the frequency of the electro-magnetic radiation falling upon it.

Mr. BLAKESLEY asked whether the tuning of the resonant jars needed re-adjustment, when the distance between their circuits was varied, for according to theory, the mutual induction should diminish the self-induction of the primary and cause its oscillations to be more rapid. If this was true the method might be used for getting rapid oscillations. He also enquired whether the glow would appear in the same position on the two stretched wires if their ends were joined.

Dr. SUMPNER wished to know how the resistances, inductances, and capacities of the circuits and jars were determined, and whether any evidence of irregular distribution of the charges on the tinfoil had been noted. With reference to the overflowing of a jar caused by wiring a certain length of discharging circuit, he asked whether the overflow did not prove the existence of a higher potential than that which originally existed between the coatings of the jar, and, if so, where did the excess energy come from?

Dr. THOMPSON asked if it would be possible to make a wire circuit analogous to an open organ pipe by putting sheets of metal on the ends of the wires.

Dr. LODGE, in reply, said Mr. Blakesley's suggestion was an important one, but he had not observed that any change in the adjustment was necessitated by varying the distance between the resonating circuits. Neither had he noticed any glow on wires joined to form a single loop, but this might be possible if the wires were long enough to give harmonics. In answer to Dr. Sumpner, he said that the capacities were difficult to determine, for with such rapid oscillations the coatings were virtually enlarged. Lord Rayleigh had shown how to calculate the inductances, and the resistances he had practically measured by his alternative path experiments. The overflow of jars he thought was caused by the charges in the some way concentrating on the edges of the foil, thus causing a kind of flood tide at which the overflow occurred.

The PRESIDENT asked Dr. Lodge what his views were as to the cause of the opacity of ebonite to light. Was it due to a selective absorption which cut off only the rays to which the eye was sensitive, or was the ordinary explanation that it contained impurities which were conducting and hence acted as screens likely to be correct? Another possible explanation was that the motion of the ether particles may be in three dimensions, and light be due to the projection of this motion on a plane perpendicular to the ray, whilst electro-magnetic induction might be due to the other component.

Dr. LODGE said he believed that ebonite was not opaque, because of conducting particles being present, and was inclined to think that it acted more like ground glass, in which the opacity was due to internal reflections. Such a substance would only be opaque to vibrations whose wave length were comparable with the size of the particles.

A note "On the Construction of Non-inductive Resistances," by Prof. W. E. Ayrton, F.R.S., and Mr. T. Mather was postponed until next meeting.

NEW PATENTS—1891.

8,873. "Improvements in the construction of telephones, electric bells, and parts relating thereto." J. F. BENNETT and E. P. HIDES. Dated May 26th.

8,874. "Improvements in telephones and electric bells." J. F. BENNETT and E. P. HIDES. Dated May 26th.

8,876. "Improvements for recording or registering the time during which an electric current is in circuit. A. HOSTER. Dated May 26th.

8,924. "Improvements in fuse blocks for electric circuits." H. H. LAKE. (Communicated by H. S. Kaliske, United States.) Dated May 26th. (*Complete.*)

8,927. "Improvements in electro-magnetic tools.' W. PAYNE-GALLWEY, W. S. RAWSON, and WOODHOUSE AND RAWSON UNITED, LIMITED. Dated May 26th.

8,932. "Improvements in electric locomotives or street car motors." H. H. LAKE. (Communicated by R. Eickemeyer, United States.) Dated May 26th. (*Complete.*)

8,961. "An improved method of measuring electrical currents by expansion of fluid contained in hollow conductors heated by the currents." A. CAMPBELL. Dated May 26th.

8,991. "An improved electric fire-alarm." G. BISHOP. Dated May 27th.

9,048. "The lighting by electricity of all vehicles drawn by horse

mules and other animals." F. COGAN, T. WRIGHT, and R. COLLINS. Dated May, 28th.

9,073. "Improvements in electric railways." J. F. MUNSIE. Dated May 28th. (*Complete.*)

9,145. "Improvements in electrical measuring instruments.." H. C. L. HOLDEN, B. M. DRAKE, and J. M. GARHAM. Dated May 29th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

1,007. "Apparatus for separating ores and metals by the aid of electricity." E. FERRARIS. Dated January 20th. 6d. Consists in an arrangement on the arms of a wheel of a number of electro-magnets which are connected with one another, and with a collector located at right angles to the axis of the wheel; and of a rim or crown of magnetic metal surrounding the wheel, on which rim the ore or metal is carried and separated by the change in the electric current. 2 claims.

1,279. "Improvements in and relating to electric signals for railways." E. C. WILEY, J. A. DICKEY, and N. B. AINESWORTH. Dated January 23rd. 8d. Consists generally of two line wires extending parallel with the track or way, said line wires having branches leading therefrom to points adjacent to one of the rails, together with devices operated by the car wheel and circuit closing brush on the locomotive tender to connect one of the wires with the track and the other with the brush contact, to the end that when an oppositely moving locomotive reaches one of the devices, it will through its contact brush close the circuit through a bell and the rail and receive an alarm. 6 claims.

2,337. "Improvements in electro-magnetic motors." G. R. POSTLETHWAITE. Dated February 13th. 8d. Consists of forming a circuit or magnetic field, of any unlimited number of magnets, so that any relative number of such magnets can be made to operate upon a revolving armature, made up with an equal number of bars, so that each such magnet attracts each of such armature bars simultaneously, and so successively as to equal one continuous field of attraction of a most powerful nature throughout its entire revolution and without any release or dead point. 9 claims.

3,336. "Improvements relating to welding, brazing, or otherwise joining metal strips, bars, rods, and the like by electricity, and to apparatus therefor. H. H. LAKE. (Communicated from abroad by H. Lemp and L. M. Schmidt, both of America.) Dated February 24th. 8d. Relates to a process of forming longitudinal metal joints in which the heating necessary to obtain the joint is produced by means of a current of electricity, and the welding or joining action is obtained by force expanded in a direction practically at right angles to the length of the pipes or pieces to be joined. 4 claims.

3,495. "Non-percussive quick break electric switch." C. M. DORMAN and R. A. SMITH. Dated February 26th. 6d. The object of the invention is to prevent the percussive action which generally takes place in switches of the sudden release type, when the contact arm flies off against a rigid stop, tending to derange the mechanism of the switch. 2 claims.

3,609. "Improvements in electricity meters." E. HARTMANN and W. BRAUN. Dated February 27th. 6d. Consists of a unipolar machine or apparatus, on the principle of Barlow's wheel, through the disc of which, preferably of copper, the current to be measured or metered, is led, the magnetic field being formed by a powerful electro-magnet magnetised by a constant current. 2 claims.

3,673. "Improvements in electric arc lamps." A. C. SEIBOLD. Dated February 28th. 8d. The inventor makes a negative electrode capable of being used in any arc lamp, without regard to the particular construction or operation of the lamp, this negative electrode being composed in part of a body of metal of low resistance, and in part of a body of carbon covered by metal, whereby the air is wholly excluded from contact with the carbon, which is kept cool by the body of metal sustaining it, thus rendering it practically unconsumable. 4 claims.

4,767. "Improvements in electromotors and dynamos." J. VAUGHAN SHERRIN. Dated March 26th. 8d. The field magnet is in solid block form, but consisting or built up of very thin laminæ with very thin intermediate insulating layers of or combined with cementing material. The laminæ are stamped out of charcoal sheet-iron. The brush-holder appliance is on a collar or socket, which by means of a set screw is fixed upon the boss or bearing in which the armature spindle rotates. From this socket is carried out an arm at each end, and upon the outer end of each arm is swivelled the brush-holder proper. 2 claims.

4,858. "Improvements in multi-polar dynamo-electric machines." G. KAPP. Dated March 28th. 8d. The inventor employs a cylindrical armature core and arranges the armature circuit on any of the known systems of multi-polar drum winding, with either series or parallel connections. The field consists of an even number of magnets placed radially around the armature and having their outer ends magnetically connected by a common yoke ring. Instead of building up the core of the armature from complete discs of wrought iron, he constructs it from segments of discs and thus effects a considerable economy in the amount of material employed. In cutting out the segments he forms on their inner edges two or more lugs which are perforated for the passage of holding bolts. The positions of these lugs are such that following segments when threaded on the holding bolts break joint with each other. 4 claims.

14,197. "Improvements relating to the use of electric motors and to the regulation or control of machinery operated thereby." W. R. LAKE. (Communicated from abroad by the Thomson-Houston International Electric Company, of America.) Dated September 9th. 11d. Consists in providing for any machinery which it is desired to operate by electricity with varying speed and power two electric motors which are connected to the machine, so as to co-operate in driving it. 9 claims.

15,455. "Improvements in or appertaining to welding metals electrically." W. P. THOMPSON. (A communication from abroad by C. L. Coffin, of America.) Dated September 30th. 6d. Consists in performing the welding operation under water. 2 claims.

17,560. "Improvements in and relating to locked switches for electric current circuits." J. A. ILIFFE and H. BARTON. Dated November 1st. 8d. The invention constitutes improvements upon Letters Patent No. 6,267, dated April 29th, 1887, and No. 18,825, dated December 24th, 1888. Consists in the use of cylindrical contacts, instead of face contacts upon a flat plate, as formerly; forming and arranging the brush so as to produce an automatic outward or radial spring against the cylindrical contact pieces instead of downward pressure, thus dispensing with the vertical contact spring hitherto employed; means for compensating for wear upon the contacts; a new method of attaching the handle to the spindle; an improved or cheaper method of constructing and finishing the contact pieces and of mounting them upon the slate or other base used.

18,190. "Improvements in multiplex telegraphy." C. A. GIBORNE. (A communication from abroad by D. H. Keeley, of Ottawa.) Dated November 11th. 8d. The invention provides for the accommodation of intermediate as well as terminal stations, and is devised to utilise the capacity of a telegraph wire for the transmission of electrical effects to the fullest extent. 7 claims.

18,409. "Improvement in electrical switches and other electrical apparatus." L. A. DAVIES. Dated November 15th. 6d. Relates to the use of buckled metal plates for causing an instantaneous make or break of electrical contacts in electrical switches and other electrical apparatus. 3 claims.

18,993. "Improvements in and relating to electric clocks." N. PROKHOROFF and N. FAHLBERG. Dated November 22nd. 8d. Relates to electric clocks in which a primary clock regulates the secondary clocks through the medium of an induction current. 2 claims.

19,272. "Electric soldering irons." C. E. CARPENTER. Dated May 10th. (Under International Convention.) 8d. This invention relates to improvements in electric soldering irons. The prime object of the improvements is to heat and confine the heat only to that portion of the iron which is employed in practice, viz., the head or point thereof, whereby the compactness, simplicity, and effectiveness of the iron are increased, and the iron is rendered easier of manipulation and more economical in use. 5 claims.

20,099. "Improvements in telephone exchange apparatus." J. E. KINGSBURY. (A communication from abroad by the Western Electric Company, of Chicago.) Dated December 9th. 8d. Relates to telephone exchange systems in which metallic circuits are employed, and its object is to provide for uniting any two circuits together without including in the united circuit thus formed any electro-magnetic device or devices other than the telephones of the subscribers who are thus connected together, while at the same time means are provided for signalling between the central office and the different subscribers for the connections and disconnections as occasion may require. 13 claims.

20,111. "Improvements in apparatus for use in the electrolytic decomposition of metallic salts." H. H. LAKE. (Communicated from abroad by I. L. Roberts and T. H. McGraw, both of America.) Dated December 9th. 8d. Relates to the use of a diaphragm or partition interposed between the two electrodes, which is impervious or practically so, to the solutions used, and permits their diffusion and intermingling, but does not prevent, or materially impede, electrolytic action. 16 claims.

20,134. "Improvements in suspenders for suspending electric light and other cables from a carrying wire." W. P. J. FAWCUS and E. W. COWAN. Dated December 10th. 6d. The form of the improved suspender is that of a belt or link with an opening for the insertion of the cables, this opening being cut or otherwise made, in an inclined or sloping direction to prevent the cables being accidentally jerked out of the suspender. 2 claims.

20,612. "Improvements in socket-holders for incandescent electric lamps." W. WHITE. Dated December 17th. 6d. Relates to a simple and inexpensive construction of socket holders for incandescent electric lamps in such a manner that within moderate compass considerable contact surfaces are obtained, and effective insulation of the two lamp conductors from each other and from the metal case. 2 claims.

20,307. "Improvements in electrical switches." C. G. DAHLGREN and J. H. SVENSSON. Dated December 12th. 6d. According to this invention, the moving contact plate is adapted to be brought into contact with, or out of contact with, the fixed contact plate by means of a spring which, normally not in a state of tension, is tensioned in the one or other direction by the turning of the turn button, the shaft of which also serves as a temporary detent for holding the said moving contact plate in its respective first position until sufficient tension has been given to the spring by turning the button to cause it, when released by the turning of the button, to leap from its position of contact to its position of disconnection, or *vice versa*, and thus suddenly interrupt or make contact with the fixed contact plate. 2 claims.

CORRESPONDENCE.

Electric Omnibuses.

In your remarks on this subject in your last issue, you infer that uncertainty as regards the economy is the reason of the non-appearance of the line of six. I assure you this is not the cause.

Circumstances have led to one car being started first; a new full-sized omnibus to do the work of an ordinary horse car is now being built, and I hope you and your readers will within a reasonable time have practical evidence of the great commercial importance of this branch of electric traction.

Technical reasons have not caused the long delay. The cost of running is clearly ascertainable if we know (1) The cost of electric energy to charge the accumulators; (2) The actual energy necessary to carry a given weight over streets as opposed to rails; (3) The cost of maintenance of the appliances.

On the first it will at once be admitted there need be no doubt. I may observe that when generating plant is run at full load about 17 hours per day, as will be the case for omnibus work, the price per unit comes out low compared to that on an electric lighting station with a light load and heavy load for a short time, although the experience of lighting stations with corrections for this better working condition will give reliable data.

On the second point the most elaborate tests have been made with the first omnibus; the energy required is known precisely. On the third, I am aware many will say that is precisely what is not known; but, as a matter of fact, it is known *that with proper usage* a certain number of discharges can be obtained from accumulators before renewals of plates is requisite. The success of a car installation, like other things, entirely depends on the details. You will admit that when the maintenance of motors and gearing is allowed to reach 50 per cent., it is a proof that they are being abused and worked under bad conditions. If I remember rightly, the cost of maintenance of motors and gear on the Brussels cars reached £90 per annum. This at once shows the futility of citing such a case against accumulator traction. I think Mr. Reckenzaun has stated his conviction that 1d. per car mile is ample for accumulator maintenance. Electric contractors *using proper appliances* can make a large profit on maintaining at one penny per mile on a fair number of cars.

It is frequently observed that it is easier for electric traction to compete on rails than on ordinary streets. This is fallacious, as it overlooks the fact that if a ton of accumulators cannot do as much work on the street as on a rail neither can a horse.

The recent rise in the cost of omnibus working makes electricity of more interest than ever to those concerned. Its use will be advantageous alike to the proprietors and *employés*. Horse drivers can easily work electric cars.

If we run 25 omnibuses from one station we can do it at 3d. per mile, including all maintenance, as compared with 4¾d. horse cost. This is based on present price of accumulators; they will be cheaper before long.

Radcliffe Ward.

June 25th, 1891.

Crompton v. Phillips, Phillips v. Crompton.

My attention has been drawn to the report of this case in your issue of the 26th inst., in which I observe that you have omitted to state that Mr. Phillips's counsel applied for and obtained a stay of execution, and in addition stated that an appeal would at once be entered. This notice of appeal has been delivered to-day.

I shall feel obliged by your kindly inserting this letter in your next issue.

R. Free,
Solicitor to Messrs. Phillips Bros.

June 29th, 1891.

Lightning on Electric Light Circuits.

While our dynamo was running early on Thursday evening an electrical storm passed over the town of a severe kind. The lightning was very vivid and forked, and in close proximity, as the flash and thunder clap were nearly simultaneous.

This storm had a striking effect on the dynamo and installation, causing the voltmeter to vary quite 60 volts. We were running at about 60 volts, as it was not dark but for storm. Our dynamo is compound shunt-wound, and 110 volts 45 ampères.

The voltmeter before each electrical discharge ran back about 30 volts, and immediately after the flash it ran up just as suddenly to about 80 volts, and in one case to nearly 100.

As I was under the impression that electric light installations were free from disturbances of this kind, as there is no earth, I shall be pleased if, through the medium of the ELECTRICAL REVIEW, you can give me any information on the subject.

J. R. Busbridge.

June 26th, 1891.

Magnetic Separators.

I notice in your commentary of the electrical apparatus at the Royal Agricultural Show, that you do not notice the magnetic separator shown by the Hardy Patent Pick Company, of Sheffield, and made under the patents of Mr. Elliot, myself, and Mr. C. W. Atkinson. This is the more curious, as the separator was by no means a small machine, being nearly 5 feet in diameter, and weighing probably, with the timber work on which it was mounted, over a ton.

As this is the first time this machine has been publicly exhibited, and as we believe it is an important improvement on any magnetic separator previously used for this purpose, we should be glad if you would note this correction. I may also add that a magnetic separator of a different class was exhibited by Messrs. Harrison, Carter and Co.

Llewellyn B. Atkinson.

June 29th, 1891.

Meter Registration.

Your note, page 822, is rather startling! One never sees the Edison (voltametric) ammeter advertised in this country; do you know if it is at all generally used, and where it can be obtained? I have often tested my own meters by the voltametric method, using copper deposition (which seems easier than silver for amateur work). And when the voltameter is inserted in the the actual leading wire, its results cannot be challenged, with ordinary care. But will this be the case, when the cell is shunted so as to receive a hundredth, or thousandth, of the full current. The resistance of the main circuit will vary, I presume, from time to time, as lamps are switched on and off; but the resistance of the shunt wire is invariable, I believe, and so the exact proportion will not be invariably maintained.

Prescott's book describes a form of Edison's meter, which combines the dial with deposition; the plates becoming positive and negative alternately, and causing a balance beam to oscillate.

But for all you say, consumers generally would rather pay an extra percentage, by dial reading, than have to superintend the mess of weighing and washing the plates of a voltameter.

Ajax.

Low Tension Mains and Glasgow Lighting.

Referring to your leaderette on Glasgow electric lighting (June 26th), you remark that Sir William Thomson's report contains a "warning as to future possible claims for royalty on usage of low tension mains."

This may or may not refer to the bare conductor system as used by Mr. Crompton, seeing that he has been consulted in the matter. If it does, it may interest the Glasgow Corporation to know, that the first section ever laid was tried by me under Scottish soil, and found in perfect condition after 18 months' use.

In the course of conversation with Mr. Crompton in London I mentioned my experiences, and subsequently found that during my absence abroad he had patented the bare conductor system, covering and claiming most of the details that I had previously worked out and found successful.

Under these circumstances I fail to see how any claim for royalty on these mains could be substantiated.

Sydney W. Baynes,
Managing Engineer Bradford Central Station.